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Haddock on the Southern Scotian Shelf and Bay of Fundy in 2011 (NAFO Division 4X5Y)

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Foreword

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

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TABLE OF CONTENTS

Abstract iv
Résumé v
Introduction 1
The Fishery 2
Commercial Landings 2
Removals at Age and Size, and Weights at Age 3
Surveys 3
Summer Research Vessel Surveys 3
Industry Surveys 4
Estimation of Stock Parameters and Results 5
Production Modelling and Biological Reference Points 6
Projections 6
Conclusions 6
Sources of Uncertainty 7
References 7
Tables 8
Figures 28
Appendix 57
Results of Testing against Reference Collection 57

ABSTRACT

Landings of 4X5Y haddock in Northwest Atlantic Fisheries Organization Division 4X5Y in the fishing year ending 31 March 2010 were 5,831 t, relative to a quota of 7,000 t and 5,370 t in the fishing year ending 31 March 2011, relative to a quota of 6,000 t. The quota in the 2011 fishing year remains at 6,000 t. The summer research vessel survey biomass index in 2011 was below the short (5 year: 50,470 t), medium (15 year: 51,434 t) and long-term (since 1970: 56,686 t) averages, and has been relatively stable over the past eight years. The weight at age of 4X5Y haddock remains low as there have been declines in both length at age and condition for most ages since the early 1990s. Recent recruitment has been variable with poor year classes in 2007 and 2008 and large year classes in 2009 and 2010. Based on a sequential population analysis model, the spawning stock biomass (SSB: ages 4+) has remained relatively stable over the past two decades. A strong retrospective pattern (tendency to overestimate biomass) in the model indicates that recent increases in SSB are likely overestimates. Maximum sustainable yield (MSY) was estimated as 14,700 t and SSB at MSY (SSB_{MSY}) was estimated at 52,000 t. A limit reference point (LRP) of 40% SSB_{MSY} (20,800 t) and upper reference point (UPR) of 80% SSB_{MSY} (41,600 t) are suggested as illustrative biological reference points. The SSB of 4X5Y haddock is considered likely to be within the cautious zone (above the LRP) and unlikely to be in the critical zone, despite uncertainties with the model. The model was considered insufficient to provide meaningful projections for the next two years. A framework review for 4X5Y haddock is recommended, given the continuing strong retrospective pattern in the model and its poor fit to the survey indices.

L'aiglefin du sud du plateau néo-écossais et de la baie de Fundy en 2011 (division 4X5Y de l'OPANO)

RESUME

Les débarquements d'aiglefin en provenance le division 4X5Y de l'Organisation des pêches de l'Atlantique Nord-Ouest au cours des années de pêche ayant pris fin le 31 mars 2010 et le 31 mars 2011 se sont chiffrés à 5 831 t et à 5 370 t, respectivement, par rapport à des quotas de 7 000 t et de 6 000 t. Le quota de l'année de pêche 2011 est resté fixé à 6 000 t. L'indice du relevé d'été par navire scientifique de 2011 se situait en dessous de la moyenne à court terme (5 ans : 50 470 t), à moyen terme (15 ans : 51 434 t) et à long terme (depuis 1970 : 56 686 t). De plus, l'indice s'est révélé plutôt stable au cours des huit dernières années. Le poids selon l'âge de l'aiglefin le division 4X5Y reste bas, puisque des diminutions de la longueur et de la condition selon l'âge ont été observées pour la plupart des tranches d'âge, et ce, depuis le début des années 1990. Le recrutement récent a été variable, affichant des classes d'âge difficiles en 2007 et en 2008 et des classes d'âge abondantes en 2009 et en 2010. Selon un modèle d'analyse séquentielle de population, la biomasse du stock reproducteur (BSR, tranche d'âge de 4 ans et plus) est demeurée relativement stable au cours des deux dernières décennies. Une tendance rétrospective marquée dans le modèle (la tendance à surestimer la biomasse) indique que les augmentations récentes de la biomasse du stock reproducteur sont probablement surestimées. La production maximale soutenable (PMS) a été estimée à 14 700 t et la biomasse du stock reproducteur de la PMS (BSR_{PMS}) a été estimée à 52 000 t. Un point de référence limite de 40 % de la BSR_{PMS} (20 800 t) et un point de référence supérieur de 80 % de la BSR_{PMS} (41 600 t) ont été suggérés comme des points de référence biologiques indicatifs. La BSR de l'aiglefin le division 4X5Y est considérée comme étant susceptible d'être dans la zone de prudence (supérieur au point de référence limite) et comme étant peu probable d'être dans la zone critique, malgré les incertitudes concernant le modèle. Le modèle a été jugé insuffisant pour ce qui est de fournir des prédictions utiles pour les deux prochaines années. Compte tenu de la tendance rétrospective marquée continue du modèle et de la correspondance faible du modèle aux indices du relevé, une évaluation du cadre de travail pour ce qui est de l'aiglefin le division 4X5Y est recommandée.

INTRODUCTION

Haddock (*Melanogrammus aeglefinus*) are found on both sides of the North Atlantic. They occur in the northwestern Atlantic from southwest Greenland to Cape Hatteras. The species is a bottom dwelling member of the cod family that occurs most commonly at depths of 25 to 125 fathoms (46-228 m) and at bottom temperatures above 2 °C. Their diet consists mainly of small invertebrates.

A major stock exists in the southern Scotian Shelf and Bay of Fundy (NAFO Division 4X5Y). Growth rates of haddock in the Bay of Fundy (NAFO Division 4Xqrs5Y) are higher than those of haddock on the southern Scotian Shelf (NAFO Division 4Xmnop) (Hurley et al. 1998). Major spawning grounds are found on Browns Bank and peak spawning occurs in April to May.

The last assessment of NAFO Division 4X5Y haddock was conducted in November 2009 (DFO 2010). Fisheries and Oceans Canada's (DFO) Resource Management Branch in the Maritimes Region requested science advice on stock status for the 2012-13 and 2013-14 fishing years, including establishing precautionary approach reference points (DFO 2012). These reference points are essential to the development of the Integrated Fisheries Management Plan (IFMP) and required by industry to meet conditions for eco-certification of the 4X5Y haddock fishery by the Marine Stewardship Council (MSC).

The objectives of the assessment were:

- Evaluate biological and fishery information on 4X5Y haddock stock status and characterize the uncertainty of the results. In particular, provide available information on distribution, biomass estimates, length composition, age composition and condition, highlighting any trends over the long-term (duration of the summer Research Vessel (RV) survey), mid-term (past 15 years) and most recent period (5 years).
- Evaluate the consequences of different harvest levels during the 2012-13 fishery on stock abundance and exploitation rate. Where possible, provide the following information:
    - For a range of total catch values, estimate the risk that fishing mortality rate (F) would exceed F=0.25, F=0.32, or any other suitable candidate. Include a table showing the catch levels corresponding to low (25%), neutral (50%) and high (75%) probability that the F would exceed F=0.25, F=0.32 or any other suitable candidate.
    - For a range of total catch values, estimate the risk that the biomass would decline by 10%, remain stable or increase by 10% from the previous year's level.
    - Estimate the risk that the fishing mortality rate would exceed F=0.25, F=0.32 or any other suitable candidate in 2012-13, and the risk that biomass would decline by 10%, remain stable or increase by 10% at a catch of 6900 t or 5100 t (plus or minus 15% of the 2011-12 Total Allowable Catch (TAC)).
- Identify appropriate reference points for 4X5Y haddock and evaluate the current status of haddock in relation to these reference points.

This assessment includes the summer RV survey data up to July 2011 together with commercial landings data for the first half of 2011 and port sampling. As in previous assessments, haddock caught by Canadian fishers in Division 5Y are included in the 4X5Y haddock management unit. Given that haddock grow faster in the Bay of Fundy than in the southern Scotian Shelf, haddock landings from Divisions 4Xmnop and 4Xqrs5Y are handled separately. Separate age-length keys are used for landings from the two areas, designated Bay of Fundy and Scotian Shelf, respectively (Figure 1). The catch at age is calculated separately

for each area and then combined to get the total catch at age for 4X5Y. Similarly, haddock catches from the summer RV survey from the Scotian Shelf (strata 470-481) and the Bay of Fundy (strata 482-495) are handled as separate components and subsequently combined to produce numbers at age for the entire survey area.

The stock is modelled using a similar Sequential Population Analysis (SPA) model and data framework as Mohn et al. (2010). Discarding and high-grading of haddock appear to be negligible (Hurley et al. 2009), therefore, the catch at age is assumed to be well estimated. The catch is assumed to be known without error and the model is tuned to two surveys; the summer RV survey and a joint industry/DFO survey (Individual Transfer Quota (ITQ) survey).

THE FISHERY

Haddock is harvested as part of a mixed, multi-species fishery that includes other groundfish such as cod, halibut, redfish, pollock and flounders, making it difficult to define a 'haddock' fishing trip. Consequently, catch is reported for all groundfish trips for mobile and fixed gear. To some extent the haddock fishery is limited by the incidental catch of cod. There are strict cod by-catch limits and haddock fishers choose time, location and methods to avoid them. A growing number of fishers are using separator panels to reduce cod by-catch, equipment that is mandatory on Georges Bank (Division 5Z). A seasonal spawning closure, instituted in 1970, currently extends from February 1st to June 15th. The history of this area closure is documented by Halliday (1988).

COMMERCIAL LANDINGS

The history of the fishery was reviewed in detail by Hurley et al. (2009). The landings reported annually from 1960-2010 averaged 12,888 t with the highest landings occurring in the mid to late 1960s and during the early 1980s (Table 1). Landings have been less than 8,700 t since 1996. The TAC was 7,000 t from 2006-2009, but was subsequently reduced to 6,000 t for the fishing years 2010-11 and 2011-12 (Figure 2). Landings have remained steady over the past six years (2005-2010), averaging about 5,700 t since 2005. Landings of 4X5Y haddock in the fishing year ending 31 March 2010 was 5,831 t and 5,370 t in the fishing year ending 31 March 2011. These landings were lower than the quotas of 7,000 t for the 2010 fishing year and 6,000 t for the 2011 fishing year.

Haddock landings are shown by gear type in Table 2. The fishery has been dominated by the mobile gear sector from 1977-1989 and since 1994 (Table 2; Figure 3). Between 1990 and 1994, the fixed gear sector took a larger proportion of the landings (Figure 3). Fixed gear landings are primarily from longlines; gillnets contributed a minor proportion of the total landings, averaging 6 t from 2005-2010 (Table 2). Landings by handlines declined from 600 t (13% of total landings) in 1994 to none since 2007 (Table 2). Since 1995, the proportion landed by the mobile sector has increased to 77% in 2010 (Figure 4).

Haddock landings by month and gear are shown in Table 3 and by quarter in Figure 5. Over half of the catch comes from the third and fourth quarter (Figure 5).

Haddock landings by unit area and gear type are shown in Table 4 and Figure 6. From 2003-2008, mobile gear landed fish from the Bay of Fundy and the edge of Georges Bank and Browns Bank on the Scotian Shelf, while fixed gear landings were from the edge of Georges, Browns Bank and near Halifax (Figure 7). The distribution of the fishery has changed in the last decade with effort shifting from the Bay of Fundy to NAFO Unit Area 4Xp (figures 8, 9). About 80-90% of the 4X5Y haddock fishery is on the Scotian Shelf and only about 10% of the landings are from the Bay of Fundy. About 50% of the haddock landings have come from Unit Area 4Xp

in the last four years (Figure 9). Of these, a substantial proportion (15-20%) was caught very close to the 4X/5Z boundary (Table 5; figures 10, 11). It is unknown whether this is a fishery effect or a change in haddock distribution. An unknown amount of Georges Bank (5Z) fish may be caught along this line and at present, there is no established method to estimate the degree to which this may be occurring. The influence on model projections or advice is unknown.

REMOVALS AT AGE AND SIZE, AND WEIGHTS AT AGE

Port sampling data (Table 6) were used to generate the catch at age in 2009 and 2010, using a similar stratification as in Mohn et al. (2010). Annual weight/length parameters were calculated from the summer RV surveys for each stock component each year. Age composition was generated by applying age-length keys to length frequencies by quarter and area. Landings were separated into 4Xmnop and 4Xqrs5y and separate age-length keys were used whenever possible. When insufficient samples were available to satisfy the stratification, length frequencies were aggregated and a common age-length key was applied. The catch at age from 1970 to 2008 was taken from Mohn et al. (2010).

Ages were assigned to otoliths by a single ager. As a routine check, the ager initially read the 4X haddock otolith reference collection. A pair-wise comparison of ages showed high precision and little bias with an overall coefficient of variation of 1.9% (Appendix). These results were considered acceptable.

The resulting catch at age is shown in Table 7 and the age composition is shown in Figure 12. The 2003 year class continues to dominate catches, appearing as age 7 in 2010. Subsequent year classes appear relatively weak.

Mean weights at age are reported in Table 8. A decline in weight at age in the late 1980s and its effect on stock productivity has been discussed in the previous assessments (Hurley et al. 2009; Mohn et al. 2010). Mean weight at age in the commercial landings have been variable since the 1990s without trend for age 3 and a modest decline for ages 5, 7, and 9 (Figure 13). Since 2007, there has been an increase in the mean weight at age for ages 5, 7, and 9 in the southern Scotian Shelf and for age 9 in the Bay of Fundy (Table 9; figure 14a, 14b). All other ages have varied without trend since 2007.

SURVEYS

SUMMER RESEARCH VESSEL SURVEYS

A stratified random design bottom trawl RV survey of the Scotian Shelf and Bay of Fundy has been conducted every summer since 1970 (Figure 15). Three vessels and two types of gear have been used. From 1970 to 1981 the survey was conducted by the RV *A.T. Cameron* using a Yankee 36 otter trawl. The *Alfred Needler* replaced the *Cameron* in 1982, and the survey has since been conducted using a Western IIA bottom trawl. In 2004 and 2007, the survey was conducted using the *Teleost* instead of the *Alfred Needler*. Based on an analysis of comparative fishing experiments by Fanning (1985), a conversion factor of 1.2 is required to calibrate the abundance series prior to 1982 to account for the effect of vessel and gear changes between the *A.T. Cameron* and the other two vessels. An analysis of comparative fishing experiments showed no conversion factor was required between the *Teleost* and *Alfred Needler* for haddock (Fowler and Showell 2009).

Numbers at age from the summer RV survey are presented in Table 10 and Figure 16. Mean weights at age are presented in Table 11. Because of the observed differences in growth rates, haddock catches from the Scotian Shelf (strata 470-481) and the Bay of Fundy (strata 482-495)

are calculated as separate components and then combined to generate numbers and weights at age for the entire RV time series.

Survey trends in both numbers and biomass show relatively high abundance in the early to mid 1980s, followed by a decline to relatively low levels over the period 1987-1994. Abundance increased in 1998-2001, but declined subsequently (Figure 17) and has been relatively stable for the past eight years. The 2011 biomass index (47,874 t) was below the short (5 year: 50,470 t), medium (15 year: 51,434 t), and long-term (since 1970: 56,686 t) averages (Figure 18). However, it has been relatively stable over the past eight years.

The RV survey abundance at length for 2010 and 2011 are above the long-term average for lengths less than 12 cm, indicating good recruitment for both the Bay of Fundy and Scotian Shelf stock components (Figure 19).

The weight at age of 3 year old Haddock has declined slightly in both the Bay of Fundy and Scotian Shelf, but the decline in weight at age of older fish (5 and 7 year olds) has been more dramatic, especially since the early 1990s (Figure 20). Weight at age has shown a modest increase for both areas since 2007.

The length at age for ages 3, 5 and 7 has declined in both the Bay of Fundy and Scotian Shelf although growth has improved since 2005 (Figure 21). Condition measured as predicted weight at 43 cm has declined for both the Scotian Shelf and the Bay of Fundy over the summer RV survey time series (Figure 22). The two factors combine to produce very low mean weights at age relative to the earlier period in the time series.

Total mortality (Z) estimated for ages 5-9 from the summer RV surveys, while variable, shows a declining trend since 1996 (Figure 23), and likely reflects the higher survey abundance during this period.

The proportion of the historical stock area encompassing 75% of the annual estimated survey biomass was calculated as an index of spatial distribution (Figure 24). The index declined in the late 1980s and early 1990s, but has increased subsequently, indicating that the 4X5Y stock is widely distributed within its range.

INDUSTRY SURVEYS

A standardized groundfish survey has been conducted in 4X by the Individual Transferable Quota (ITQ) mobile gear < 65' fleet since 1995. Sampling since 1996 has been sufficiently standardized for abundance estimates. The survey is conducted in July at about the same time as the summer RV survey by three commercial trawlers. All three vessels use a standardized Balloon 300 trawl equipped with a codend liner of the same mesh size as used by the summer RV survey. A fixed station design, based on the summer RV survey strata is used and standardized tows are made. The ITQ survey covers the entire 4X area including a large inshore area off southwest Nova Scotia that is not covered by the summer RV survey (Figure 25). Abundance and biomass indices are not calculated separately for Bay of Fundy and Scotian Shelf tows.

The ITQ survey indices of abundance and biomass have declined since 2001 but have been relatively stable in recent years (Figure 26). A catch at age was generated using length frequencies from the ITQ survey and age-length keys from the summer RV survey (Table 12). The ITQ survey indicates that the 2006 and 2009 year classes have been relatively strong while the 2007 and 2008 year classes were weak (Figure 27).

A comparison of trends in numbers of haddock captured in the summer RV and ITQ surveys indicates that both surveys showed a peak in 2001 followed by a decline (Figure 28). A second

peak in ITQ catch in 2007 was not apparent in the numbers of fish caught that year by the summer RV survey. Some of this is due to small fish with age 1 and age 2 representing 57% of the haddock caught compared to 33% of the haddock caught in the summer RV survey. Except for 2007, the ITQ survey has shown a similar pattern in numbers of haddock to the summer RV survey.

ESTIMATION OF STOCK PARAMETERS AND RESULTS

The assessment used a similar SPA model formulation and data framework as the two survey model used in Mohn et al. (2010). The population model was expanded to estimate ages 11-13 rather than stopping at age 10. The catch is assumed to be known without error and the model was tuned to both the summer RV survey and the ITQ survey.

Parameters:

Population numbers at mid-year: $N_{i,2010}$ where i = ages 2-13
Calibration coefficients: $q_{1,i}$ where i = ages 2-13 for summer RV survey
$q_{2,i}$ where i= ages 2-13 for ITQ survey

Structure Imposed:

Error in catch assumed negligible
Partial recruitment fixed for age 1 in 2009
F on oldest age (13) set as average F of ages 9-11 adjusted by the partial recruitment of age 13 in 2010
No intercepts were fitted
M = 0.2 for all ages

Input:

$C_{i,t}$ where i = ages 1-13; t = years 1970 to 2010 - catch at age for entire year
$J_{i,t}$ where i = ages 2-13; t = years 1970 to 2010 - summer RV survey index
$ITQ_{i,t}$ where i = ages 2-13; t = years 1996 to 2010 - ITQ survey index

Objective function:

$$\text{Minimise } \{ \sum\sum (\ln J_{i,t} - \ln q_{1,i} N_{i,t})^2 \} + \{ \sum\sum (\ln ITQ_{i,t} - \ln q_{2,i} N_{i,t})^2 \}$$

The fit of the SPA model to the summer RV survey and the ITQ survey and the residual patterns are shown in Figure 29. Recruitment and SSB are shown in Figure 30a. Recruitment of the 2003 to 2006 and 2009 year classes were good but the 2007 and 2008 year classes were poor. Estimates of population numbers, biomass, and fishing mortality from the base model are shown in tables 13, 14 and 15. Exploitation rates for ages 5-7 are below $F_{0.1}$ (Figure 30b).

The retrospective patterns in fishing mortality and SSB for the model are shown in Figure 31. The strong retrospective patterns in F and SSB reflect mismatch between the survey indices and catch information and implies that recent model estimates of biomass are overestimates.

Based on the SPA model, SSB has remained relatively stable over the past two decades (Figure 32). While this model suggests an increase in SSB in the past few years, the strong retrospective pattern (tendency of the model to overestimate biomass and underestimate F) indicates that these values are likely overestimates.

PRODUCTION MODELLING AND BIOLOGICAL REFERENCE POINTS

A Sissenwine-Shepard production model (Sissenwine and Shepard 1987) was run using the population estimates from the model. Figure 33 shows the results of this analysis using the entire summer RV survey time series.

The production model estimated Maximum Sustainable Yield (MSY) at 14,700 t, SSB at MSY (SSB_{MSY}) at 52,000 t, and F_{MSY} at 0.43 (Figure 33). Biological reference points of 40% (20,800 t) and 80% (41,600 t) of SSB_{MSY} are suggested as the limit reference point (LRP) and upper stock reference (USR) but will be reviewed at the next framework. For most of the years, SSB is between the B_{USR} and B_{LRP}, with some improvement in recent years. A target removal reference of 0.25 is suggested but requires further review.

The LRP and USR are shown with the SSB history in Figure 32. For most of the years, SSB is between the B_{USR} and B_{LRP}, with some improvement in recent years. Despite uncertainties in the fit of the population model, the SSB of 4X5Y haddock is considered likely to be within the 'cautious' zone, that is, between the LRP and USR, and unlikely to be in the critical zone.

PROJECTIONS

There is a continuing strong retrospective pattern in the model, and poor model fit to survey indices. As a result, the model was considered insufficient to provide meaningful projections for the next two years. However, for illustrative purposes, if a retrospective correction (Mohn's rho) of 0.17 is applied (i.e., SSB in the past three years is reduced by 17% in an effort to account for the retrospective), and catches of 5,500 t in 2012 (expected catch), 3,254 t in 2013 (F=0.25), and 3,226 t in 2014 (F=0.25) are assumed, SSB is projected to fall between the LRP and USR in 2012, 2013 and 2014. Figure 34 plots SSB versus fully recruited Fishing Mortality (F) since 1970, including the projected values for 2012, 2013, and 2014. If a larger retrospective correction is required, the risk that SSB would fall below the critical boundary would increase.

Given the ongoing mortality of the strong 2003 and 2006 year classes, the poor 2007 and 2008 year classes and limited growth of 4+ fish, it is expected that SSB would decline in 2013 and 2014 without any fishing. Armstrong and risk plots have been used in previous assessments to estimate the impacts of harvest levels. The projected yield at F=0.25 (which is currently used for $F_{0.1}$) is 4,500 t, while a harvest at F_{msy} would represent a catch of about 7,500 t (Figure 35). Biomass is expected to decline about 5% even in the absence of fishing. Figure 36 shows a 50% probability that fishing mortality will exceed $F_{0.1}$ at harvest levels above 3,800 t.

CONCLUSIONS

Landings of 4X5Y haddock were below the TAC in 2009 and 2010. In the last four years, the proportion of the landings by mobile gear has increased to over 70%. The distribution of fishery effort has shifted with about 50% of the landings coming from Unit Area 4Xp, and 20% of these within 5 nautical miles of the 4X/5Z boundary line.

The summer RV survey trends in abundance and biomass have been relatively stable for the past eight years. Recruitment has been variable with good year classes in 2009 and 2010. Both weight at age and condition have declined. The ITQ survey indices have been stable.

The population model used in the previous assessment shows a strong retrospective pattern in SSB, indicating that recent estimates in biomass are overestimated.

Biological reference points were developed for 4X5Y haddock as an illustrative exercise. Despite uncertainties in the fit of the model, the population is likely to be in the cautious zone and not in the critical zone. The model was not considered reliable enough to develop

projections but a retrospective correction (Mohn's Rho) was applied for illustrative purposes. Given the ongoing mortality of the strong 2006 year class, followed by two poor year classes (2007, 2008), and limited growth of age 4+ fish, it is expected that SSB would decline in 2013 and 2014 without any fishing.

A framework review is recommended for 4X5Y haddock, given the strong retrospective pattern in the model and the poor model fit to survey indices.

SOURCES OF UNCERTAINTY

There are differences in growth between the Bay of Fundy and Scotian Shelf portions of this resource. Changes in fishing patterns may affect the development of the catch at age.

It is possible that some element of the reported Unit Area 4Xp landings may be associated with the adjacent Georges Bank (5Z) stock.

As with previous assessments of this resource, the model residuals show some strong year effects, with positive residuals at all ages in some years and negative residuals at all ages in other years. The strong retrospective pattern seen in the SSB reflects a mismatch between the survey and catch information.

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TABLES

Table 1. Reported nominal catch (t) of haddock from NAFO Division 4X (Canadian landings include 5Y (FY – fishing year; TAC – total allowable catch) from years 1970 to 2010.

Year	Catch	TAC	FY Catch[1]	FY TAC[1]
1970	18,072	18,000	-	-
1971	17,592	18,000	-	-
1972	13,483	9,000	-	-
1973	13,106	9,000	-	-
1974	13,378	0	-	-
1975	18,298	15,000	-	-
1976	17,498	15,000	-	-
1977	21,281	15,000	-	-
1978	27,323	21,500	-	-
1979	25,193	26,000	-	-
1980	29,210	28,000	-	-
1981	31,475	27,850	-	-
1982	25,729	32,000	-	-
1983	27,405	32,000	-	-
1984	21,156	32,000	-	-
1985	16,131	15,000	-	-
1986	15,555	15,000	-	-
1987	13,780	15,000	-	-
1988	11,272	12,400	-	-
1989	6,800	4,600	-	-
1990	7,556	4,600	-	-
1991	9,826	0	-	-
1992	10,530	0	-	-
1993	6,968	6,000	-	-
1994	4,406	4,500	-	-
1995	5,669	6,000	-	-
1996	6,245	6,500	-	-
1997	6,527	6,700	-	-
1998	7,843	8,100	-	-
1999	6,621	8,100	9,291	9,800
2000	6,961	-	7,761	8,100
2001	8,466	-	7,411	8,100
2002	7,997	-	7,930	8,100
2003	8,706	-	8,617	8,100[2]
2004	6,553	-	5,964	10,000
2005	5,633	-	5,142	8,000
2006	4,746	-	4,687	7,000
2007	6,876	-	6,767	7,000
2008	5,372	-	5,684	7,000
2009	5,504	-	5,831	7,000
2010	5,663	-	5,370	6,000

[1] Fishing year in 1999 was extended to March 3, 2000. TAC prorated upwards. Subsequent fishing years begin on April 1.
[2] Quota increased to 10,000t from 8,100t during the fishing year.

Table 2. Reported nominal catch (t) of haddock from NAFO Division 4X5Y landed in the Maritimes by gear type and tonnage class, from years 1970 to 2010. MG = mobile gear tonnage class 1-3 and 4+, LL = longline, HL = handline, GN = gillnet.

Year	MG[1] 1-3	MG 4+	LL	HL	GN	Misc[2]	Total of Gear Categories
1970[3]	5519	6503	2961	539	88	402	16012
1971	4743	7716	3227	456	79	183	16404
1972	2942	4755	4048	498	59	268	12570
1973	1929	4233	5853	377	143	145	12680
1974	4113	1628	6211	258	166	58	12434
1975	6183	4406	4944	275	176	75	16059
1976	4390	6157	4642	714	389	46	16338
1977	6290	8346	4032	411	337	177	19593
1978	9588	8099	6072	865	573	198	25395
1979	10293	8638	4349	838	399	63	24580
1980	13131	7444	5723	1281	797	228	28604
1981	14912	6649	7008	923	856	17	30365
1982	11960	3122	6763	875	814	31	23565
1983	12988	2560	7787	786	664	56	24841
1984	12081	615	6307	492	183	4	19682
1985	10244	563	4028	336	110	33	15314
1986	9854	209	4875	469	88	13	15507
1987	8177	511	4572	286	215	3	13763
1988	7269	377	3356	126	81	23	11233
1989	3829	90	2469	221	158	27	6794
1990	3329	110	3391	396	278	0	7504
1991	4182	206	4588	539	257	1	9772
1992	3469	258	5587	974	215	5	10508
1993	2632	123	3227	865	100	1	6947
1994	2081	97	1578	600	48	2	4405
1995	3062	106	2171	250	69	2	5660
1996	3685	151	2053	298	50	0	6237
1997	4238	65	2066	110	58	0	6538
1998	5155	80	2461	141	50	0	7887
1999	4475	120	1955	40	31	0	6621
2000	4129	105	2670	29	28	0	6961
2001	6140	88	2227	11	21	0	8486
2002	5630	37	2252	55	23	0	7997
2003	6616	29	2008	26	26	0	8706
2004	5376		1140	15	22	0	6553
2005	4611	53	950	5	13	0	5633
2006	3255	174	1309	3	6	0	4746
2007	5240	50	1583	0	3	0	6876
2008	4185	0	1176	0	8	0	5369
2009	4563	0	933	0	7	0	5504
2010	4371	0	1263	0	4	25	5663

[1] Mobile gears include all kinds of trawls (e.g. otter, midwater, shrimp) and pair seine.
[2] Miscellaneous gears include trap, unknown gears, dredge, jigger, pot, squid jig and weir.

Table 3. Reported commercial haddock landings (t) by month and gear type from NAFO Division 4X5Y (from ZIF and MARFIS databases), from years 1985 to 2010 (except for trapnet landings only for 2010).

A. Total landings (t) by all gear types (mobile, longline, gillnet, handline and trapnet).

Month	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Jan	789	859	1168	2119	996	1371	1057	1519	361	404	539	396	109	419	531	644	1371	982	809	340	402	206	278	150	179	302
Feb	3898	2913	2320	1523	1447	1262	1361	1052	924	280	387	463	614	939	526	1129	603	670	398	617	577	589	362	375	846	860
Mar	626	1071	2085	216	836	288	318	366	452	139	518	481	572	1103	252	897	1496	772	1190	1351	741	435	531	537	350	540
Apr	1000	481	594	637	371	293	241	228	316	209	230	282	439	650	269	146	343	568	277	245	191	82	284	288	72	608
May	1164	1109	1363	808	245	429	542	606	676	276	314	273	194	132	324	325	413	361	569	366	176	141	209	90	159	183
Jun	2060	1059	1381	1289	906	597	942	1131	897	692	445	539	305	354	420	383	389	599	323	228	178	390	306	142	288	337
Jul	1599	1262	961	876	485	739	1086	1297	909	838	697	659	642	743	716	769	606	902	760	397	420	688	313	413	1021	500
Aug	1291	1254	777	529	504	640	877	1027	1085	366	570	578	664	654	976	745	840	936	903	618	823	570	1059	492	488	588
Sep	1585	2652	1458	1697	444	864	978	1127	797	421	572	602	899	1042	1114	788	942	816	1243	855	875	706	1269	727	837	777
Oct	1096	1613	1057	790	330	408	742	801	267	289	492	699	867	645	587	609	628	578	898	596	636	370	1384	1008	672	472
Nov	436	635	347	231	147	309	585	529	195	220	256	707	598	503	495	344	545	428	832	550	456	409	522	835	349	319
Dec	562	599	253	503	83	305	1042	825	69	268	640	559	544	705	412	182	292	388	503	391	157	160	359	314	243	177
Total	16105	15507	13763	11217	6794	7504	9772	10508	6947	4405	5660	6237	6538	7887	6621	6961	8466	8000	8705	6553	5633	4746	6876	5372	5504	5663

B. Total landings (t) by mobile gear.

Month	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Jan	331	421	448	1312	614	720	280	578	259	112	246	197	78	319	476	518	1049	780	579	224	371	152	222	79	153	216
Feb	2598	1806	1192	1037	1062	794	508	414	232	244	375	450	457	885	494	826	502	598	325	496	569	547	292	359	821	822
Mar	439	754	1739	109	667	77	122	225	223	137	518	481	539	1033	229	549	1258	621	1012	1294	724	422	485	513	340	534
Apr	792	364	520	555	289	244	159	97	107	155	117	270	399	511	241	123	296	538	252	221	166	77	260	265	66	603
May	1067	1021	1207	756	193	379	449	353	396	227	182	203	176	99	296	288	386	347	544	351	164	135	190	86	155	181
Jun	1924	900	1142	1185	735	361	589	659	467	195	185	141	249	170	305	217	269	529	257	192	148	356	261	98	276	316
Jul	1306	871	549	670	171	315	440	450	320	234	207	267	337	320	349	341	301	541	538	257	292	491	118	204	937	327
Aug	856	688	293	117	83	113	195	137	166	141	188	275	277	304	589	316	475	481	560	418	615	217	683	258	292	235
Sep	1046	1852	1009	1103	47	154	280	197	209	202	269	364	559	492	733	414	722	432	864	671	704	385	909	510	611	576
Oct	713	938	473	469	15	95	235	161	163	160	292	414	502	259	283	282	331	300	607	425	463	250	1160	805	471	255
Nov	240	206	75	89	9	100	319	163	147	121	188	453	420	340	291	226	397	221	688	463	321	277	422	733	255	185
Dec	290	242	40	248	24	87	811	293	67	252	402	319	311	504	308	133	230	282	420	364	126	119	289	278	185	120
Total	11602	10062	8687	7648	3909	3439	4388	3727	2755	2178	3168	3836	4303	5235	4595	4234	6216	5670	6646	5376	4664	3428	5290	4188	4563	4371

C. Total landings (t) by longline gear.

Month	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Jan	457	438	718	807	382	645	777	937	102	292	293	199	31	99	55	126	321	201	229	117	31	54	56	71	26	86
Feb	1300	1107	1126	485	385	463	851	638	691	36	11	13	157	54	32	302	101	72	73	120	8	41	70	16	25	37
Mar	185	316	342	104	168	205	193	140	227	2	0	0	33	71	23	347	237	150	174	51	15	13	46	23	10	6
Apr	207	117	66	81	69	48	77	127	205	53	112	12	40	139	27	22	47	30	24	22	24	5	24	23	5	5
May	91	84	138	50	47	33	87	243	275	41	126	64	16	32	27	37	27	13	25	14	11	6	19	4	4	3
Jun	99	102	180	83	115	107	236	330	223	236	162	260	102	152	102	149	116	62	55	31	28	34	46	43	12	21
Jul	159	186	291	177	229	265	444	506	294	352	363	267	254	352	335	411	297	327	210	128	122	195	194	209	83	157
Aug	291	429	367	367	357	382	481	570	608	158	372	249	344	316	377	422	355	427	328	195	203	349	375	233	195	352
Sep	448	713	361	538	325	555	524	717	471	180	230	215	323	507	372	370	215	379	376	180	169	320	359	213	222	199
Oct	357	621	516	288	266	270	427	507	84	116	197	280	357	378	299	319	295	277	288	170	172	119	223	202	200	206
Nov	190	418	259	128	110	202	262	349	45	98	68	254	178	161	202	118	147	207	143	87	135	131	100	102	94	134
Dec	271	356	210	254	54	216	229	529	2	16	238	240	232	201	104	49	62	106	83	26	31	42	70	36	58	57
Total	4056	4888	4575	3362	2506	3391	4589	5592	3228	1580	2173	2053	2066	2461	1955	2670	2219	2252	2008	1140	950	1309	1583	1176	934	1263

D. Total landings (t) by handline.

Month	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Jan	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feb	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apr	0	0	0	0	1	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
May	4	3	3	0	3	3	2	5	2	9	7	4	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Jun	35	50	41	10	43	77	97	132	189	256	91	134	40	22	6	15	3	5	9	2	0	0	0	0	0	0
Jul	118	188	88	15	75	93	184	315	284	242	117	113	43	56	25	11	2	25	9	9	2	0	0	0	0	0
Aug	101	120	94	32	48	114	138	290	297	61	9	44	21	27	5	2	5	25	7	3	2	2	0	0	0	0
Sep	54	72	44	38	31	82	77	143	81	26	23	0	3	34	1	0	0	1	0	2	0	0	0	0	0	0
Oct	15	29	10	21	15	20	39	70	9	5	3	2	3	1	1	0	0	0	1	0	0	0	0	0	0	0
Nov	5	7	2	9	4	4	1	14	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dec	0	0	3	1	1	2	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	334	469	286	126	221	396	539	974	865	600	250	298	110	141	40	29	10	55	26	15	5	3	0	0	0	0

E. Total landings (t) by gillnet.

Month	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Jan	0	0	2	1	0	6	0	4	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Feb	0	1	1	1	0	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mar	2	0	4	3	0	6	2	0	1	0	0	0	0	0	0	1	0	1	4	6	1	1	0	0	0	0
Apr	1	0	7	1	12	0	5	5	2	1	1	0	0	0	0	0	0	1	0	2	1	0	0	0	0	0
May	1	1	15	1	2	13	5	5	4	1	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0
Jun	2	7	17	11	13	51	20	10	18	5	6	4	4	10	6	2	1	3	1	3	2	1	0	0	0	0
Jul	16	18	32	14	10	66	18	26	11	10	10	12	8	16	6	6	5	9	3	3	3	1	0	1	1	0
Aug	43	16	24	14	15	31	63	29	14	7	2	9	23	7	5	5	5	3	8	2	2	2	2	1	1	0
Sep	36	15	44	18	41	72	98	69	36	13	49	22	15	9	7	4	5	4	4	2	2	1	1	4	4	4
Oct	10	25	58	13	35	23	41	64	12	9	1	2	6	6	4	8	2	0	3	1	1	0	0	1	0	0
Nov	0	3	12	4	25	4	2	3	1	1	0	0	0	1	2	0	0	0	1	0	0	0	0	0	0	0
Dec	1	2	0	1	4	0	1	0	0	0	0	0	1	1		0	0	0	0	1	0	0	0	0	0	0
Total	113	88	215	82	158	278	257	215	100	48	69	50	58	50	31	28	21	23	26	22	13	6	3	7	7	4

F. Total landings (t) by trapnet.

Month	2010
Jan	0
Feb	0
Mar	0
Apr	0
May	0
Jun	0
Jul	15
Aug	0
Sep	0
Oct	10
Nov	0
Dec	0
Total	25

Table 4. Reported commercial haddock landings (t) by unit area and gear type from NAFO Division 4X5Y (from ZIF and MARFIS databases), from years 1985 to 2010.

A. Total landings (t) by all gear types (mobile, longline, handline and gillnet).

Area	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
4XL	0	1	10	0	0	0	0	0	0	0	0	0	1	7	0	0	0	0	2	3	1	4	1	1	2	8
4XM	699	1203	814	673	432	396	515	259	144	58	95	89	90	142	180	224	228	208	124	47	45	73	28	32	15	12
4XN	1941	2055	2481	1412	952	698	1349	1402	1642	365	900	1103	1025	2539	1147	2060	2720	1930	1470	1571	1558	1295	1514	1398	1294	1991
4XO	3861	3732	3183	1656	1557	2292	3264	3898	2316	1618	1052	1158	746	877	848	856	667	783	550	244	202	341	355	365	207	427
4XP	1928	1023	1297	1212	1324	1108	1452	749	788	298	1473	1127	1477	1696	2120	1791	2179	1915	2516	2175	2229	1653	3707	2573	3317	2687
4XQ	1974	2280	1283	597	599	999	1292	1104	1124	1088	1139	1097	931	943	976	998	1022	691	620	536	343	344	535	348	371	401
4XR	1426	982	249	131	228	259	816	862	533	364	493	870	1154	1035	733	512	792	1271	1446	449	291	160	195	81	37	35
4XS	295	212	84	46	15	14	91	60	112	113	164	427	638	412	522	396	735	1062	1766	1319	857	732	412	436	165	22
4XU	3191	3794	4271	5358	1593	1729	975	2166	276	487	316	274	431	132	51	92	72	79	126	136	67	114	103	120	68	53
5Y	791	225	90	132	92	9	12	8	13	15	28	92	25	60	42	32	51	55	85	73	39	30	24	18	29	28
Total	16105	15507	13763	11217	6794	7504	9766	10508	6947	4405	5660	6237	6518	7843	6621	6961	8466	7994	8706	6552	5633	4746	6876	5372	5504	5663

B. Total landings (t) by mobile gear.

Area	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
4XL	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	7
4XM	144	295	132	269	41	35	16	32	7	3	7	10	11	25	21	16	22	6	3	1	8	2	0	0	0	1
4XN	1455	1624	2194	1007	733	468	786	939	503	187	222	541	407	1954	825	1157	1790	1150	849	1206	1304	949	972	935	1037	1604
4XO	1949	1329	1059	728	454	533	851	735	500	445	275	214	173	108	143	93	181	231	94	102	59	79	99	190	95	256
4XP	1401	538	901	963	1047	738	645	427	355	104	1018	758	1063	867	1402	1141	1702	1324	1885	1771	1849	1207	3122	2223	2861	2070
4XQ	1930	2254	1221	559	566	886	1153	912	925	999	975	995	860	803	932	941	980	605	573	482	285	294	480	318	357	371
4XR	1330	910	210	107	207	223	739	604	296	311	477	800	1121	1013	709	468	762	1235	1412	427	276	143	178	70	26	14
4XS	277	198	63	22	12	5	87	51	108	112	157	413	627	404	516	387	727	1057	1745	1309	842	723	410	435	161	20
4XU	2326	2690	2823	3896	761	543	93	21	50	2	8	14	14	4	6	0	2	5	2	8	1	3	5	1	0	0
5Y	791	224	83	97	89	7	11	6	12	14	28	92	25	56	41	30	50	54	81	69	35	25	20	12	27	28
Total	11602	10062	8687	7648	3909	3439	4382	3727	2755	2178	3168	3836	4303	5234	4595	4234	6216	5667	6646	5375	4664	3428	5290	4188	4563	4371

C. Total landings (t) by longline gear.

Area	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
4XL	0	0	10	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	2	2	1	3	1	1	1	1
4XM	493	856	552	359	256	275	409	133	113	50	82	68	73	109	150	202	199	199	120	46	37	71	27	31	15	11
4XN	485	432	286	403	219	229	561	458	1129	175	672	556	616	583	321	903	930	779	620	365	253	346	542	463	257	387
4XO	1545	1924	1798	791	861	1309	1809	2276	994	663	616	678	490	652	678	752	478	506	440	138	141	261	256	170	108	132
4XP	528	486	391	247	277	368	801	319	400	171	435	351	380	805	708	636	474	583	621	394	375	444	584	349	455	599
4XQ	33	11	54	30	28	30	97	98	178	10	149	84	61	124	31	44	35	73	40	47	52	48	55	30	14	29
4XR	86	61	33	18	9	3	45	181	202	39	13	66	30	20	22	40	29	35	33	21	14	17	17	11	11	21
4XS	6	6	2	21	1	8	1	2	1	0	3	6	8	6	2	3	5	3	14	6	14	7	2	1	4	1
4XU	858	1100	1445	1446	814	1168	863	2119	211	470	200	243	391	112	43	89	70	71	117	117	63	109	99	119	67	52
5Y	0	0	2	35	4	1	0	1	0	0	0	0	0	3	1	1	1	1	1	0	0	0	1	0	3	0
Total	4034	4875	4572	3350	2469	3391	4588	5587	3227	1578	2171	2053	2049	2421	1955	2670	2219	2250	2008	1140	950	1309	1583	1176	933	1263

Table 4. Continued.

D. Total landings (t) by handline.

Area	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
4XL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4XM	23	17	33	5	4	3	11	13	3	1	0	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0
4XN	0	0	0	0	0	0	0	0	7	2	2	5	1	1	1	0	0	1	0	0	0	0	0	0	0	0
4XO	294	426	236	111	193	376	460	844	775	486	140	248	72	111	25	9	7	45	15	4	1	1	0	0	0	0
4XP	0	0	4	0	0	0	0	1	27	21	13	13	5	2	1	5	1	1	2	2	0	0	0	0	0	0
4XQ	11	15	8	2	4	8	30	40	14	75	3	14	6	8	8	9	1	5	2	0	0	0	0	0	0	0
4XR	6	10	4	4	12	3	29	74	32	11	0	3	2	0	2	3	0	0	0	0	0	0	0	0	0	0
4XS	0	1	1	2	0	0	0	0	3	0	0	1	0	0	0	0	0	0	1	0	0	2	0	0	0	0
4XU	0	0	0	3	8	6	9	2	3	4	91	13	23	14	1	2	0	2	5	9	3	0	0	0	0	0
5Y	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	334	469	286	126	221	396	539	974	865	600	250	298	109	137	40	29	10	54	26	15	5	3	0	0	0	0

E. Total landings (t) by gillnet.

Area	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
4XL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4XM	29	31	95	40	96	82	79	79	21	4	5	10	5	7	7	5	7	3	0	0	0	0	1	0	0	0
4XN	0	0	0	2	0	1	2	5	3	0	4	1	0	1	0	0	0	0	0	0	0	0	0	0	0	2
4XO	67	47	90	26	47	74	144	42	46	21	20	17	12	6	3	1	1	1	1	0	1	1	1	5	5	0
4XP	0	0	2	3	0	3	5	1	6	3	7	6	29	22	9	10	2	7	8	9	4	1	0	0	1	1
4XQ	0	0	0	0	2	75	12	53	8	4	11	4	4	8	5	4	6	8	5	7	5	2	1	1	1	0
4XR	1	1	1	2	0	31	2	3	3	3	3	1	1	2	1	1	1	1	1	1	1	0	0	0	0	0
4XS	12	7	18	1	2	1	3	7	1	0	3	7	2	2	4	6	3	2	5	4	2	0	0	0	0	0
4XU	4	1	3	8	10	11	10	23	12	11	16	3	4	2	1	0	1	1	2	1	0	1	0	1	1	0
5Y	0	1	6	0	0	0	0	1	1	1	0	0	1	1	1	0	0	0	4	0	0	0	0	0	0	0
Total	113	88	215	81	158	278	257	215	100	48	69	50	57	51	31	28	21	23	26	22	13	6	3	7	8	3

Table 5. Landings (t) of 4X haddock aggregated by mobile gear (MG), MG in the 3rd and 4th quarters in Unit Areas 4Xp and within 5 nautical miles of the Division 4X5Z (years 2003-2010).

A. Landings (t).

	Total		Mobile Gear All quarters		Mobile Gear 3rd-4th quarters		Mobile Gear 3rd-4th quarters		Mobile Gear within 5 nm of the 4Xp/5Zj line	
Year	4X	5Z	4X	5Z	4X	5Z	4Xp	5Zj	4Xp	5Zj
2003	8706	6775	6646	4985	3677	4158	1292	3996	962	308
2004	6553	9745	5376	7744	2598	6134	1771	7330	902	199
2005	5633	14490	4664	12115	2521	8416	1849	11977	1159	1070
2006	4746	11990	3428	10090	1740	7470	877	7395	408	695
2007	6876	11890	5290	10034	3580	6958	2828	6920	2288	195
2008	5369	14781	4185	12615	2784	7485	1927	7484	882	38
2009	5504	17596	4563	15408	2751	9175	2361	9154	973	660
2010	5665	16609	4396	14133	1723	9311	1431	8891	646	561

B. Percentage (%) of total landings.

	Mobile Gear All quarters		Mobile Gear 3rd-4th quarters		Mobile Gear 3rd-4th quarters		Mobile Gear within 5 nm of the 4Xp/5Zj line	
Year	4X	5Z	4X	5Z	4Xp	5Zj	4Xp	5Zj
2003	76	74	42	61	15	59	11	5
2004	82	79	40	63	27	75	14	2
2005	83	84	45	58	33	83	21	7
2006	72	84	37	62	18	62	9	6
2007	77	84	52	59	41	58	33	2
2008	78	85	52	51	36	51	16	0
2009	83	88	50	52	43	52	18	4
2010	78	85	30	56	25	54	11	3

Table 6. Sampling data used to generate the commercial catch at age for haddock in NAFO Division 4X5Y.

A. Annual alpha and beta from 2009 from the summer RV survey for 4Xmnop: a = 0.00661; b = 3.12022 and for 4qrs5Y: a = 0.00919; b = 3.02693.

Area	Gear	Quarter	Tonnage	# measured	# aged	ALK used	Comments	# ages in AIK used
4Xmnop	mobile	1	1277	1617	182	H1mnopM	ALK made up from mobile gear, 4Xmnop, 1st half of the year	294
4Xmnop	mobile	2	294	1195	112	H1mnopM	ALK made up from mobile gear, 4Xmnop, 1st half of the year	294
4Xmnop	mobile	3	1616	1621	161	H2mnopM	ALK made up from mobile gear, 4Xmnop 2nd half of the year	284
4Xmnop	mobile	4	807	1584	123	H2mnopM	ALK made up from mobile gear, 4Xmnop, 2nd half of the year	284
4Xmnop	fixed	1	60	490	49	H1mnopallgears	ALK made up from all gears 4Xmnop, 1st half of year	343
4Xmnop	fixed	2	14	202	0	H1mnopallgears	ALK made up from all gears 4Xmnop, 1st half of year	343
4Xmnop	fixed	3	486	2008	193	H2mnopF	ALK made up from fixed gear 4Xmnop, 2nd half of year	377
4Xmnop	fixed	4	346	2185	184	H2mnopF	ALK made up from fixed gear 4Xmnop, 2nd half of year	377
4Xqrs5Y	mobile	1	38	0/727	0	H1_H2 qrsallgears	ALK made up from all gears for entire year for 4Xqrs5Y, LF from 2nd quarter	211
4Xqrs5Y	mobile	2	203	727	81	H1_H2 qrsallgears	ALK made up from all gears for entire year for 4Xqrs5Y	211
4Xqrs5Y	mobile	3	224	720	72	H1_H2 qrsallgears	ALK made up from all gears for entire year for 4Xqrs5Y	211
4Xqrs5Y	mobile	4	104	454	58	H1_H2 qrsallgears	ALK made up from all gears for entire year for 4Xqrs5Y	211
4Xqrs5Y	fixed	1	1	0/727	0	H1_H2 qrsallgears	ALK made up from all gears for entire year for 4Xqrs5Y, LF from 2nd quarter	211
4Xqrs5Y	fixed	2	7	727	0	H1_H2 qrsallgears	ALK made up from all gears for entire year for 4Xqrs5Y	211
4Xqrs5Y	fixed	3	20	0/720	0	H1_H2 qrsallgears	ALK made up from all gears for entire year for 4Xqrs5Y, LF from 3rd quarter	211
4Xqrs5Y	fixed	4	7	0/454	0	H1_H2 qrsallgears	ALK made up from all gears for entire year for 4Xqrs5Y, LF from 3rd quarter	211

B. Annual alpha and beta from 2010 from the summer RV survey for 4Xmnop: a= 0.00609; b = 3.11825 and for 4qrs5Y: a = 0.00549; b = 3.14669.

Area	Gear	Quarter	Tonnage	# measured	# aged	ALK used	Comments	# ages in AIK used
4Xmnop	mobile	1	1472	965	95	H1mnopM	ALK made up from mobile gear, 4Xmnop, 1st half of the year	277
4Xmnop	mobile	2	886	2151	182	H1mnopM	ALK made up from mobile gear, 4Xmnop, 1st half of the year	277
4Xmnop	mobile	3	1052	1891	188	H2mnopM	ALK made up from mobile gear, 4Xmnop 2nd half of the year	277
4Xmnop	mobile	4	528	972	89	H2mnopM	ALK made up from mobile gear, 4Xmnop, 2nd half of the year	277
4Xmnop	fixed	1	127	0/992	0	H1mnopallgears	ALK made up from all gears 4Xmnop, 1st half of year	358
4Xmnop	fixed	2	25	992	81	H1mnopallgears	ALK made up from all gears 4Xmnop, 1st half of year	358
4Xmnop	fixed	3	683	1918	175	H2mnopF	ALK made up from fixed gear 4Xmnop, 2nd half of year	384
4Xmnop	fixed	4	401	2348	209	H2mnopF	ALK made up from fixed gear 4Xmnop, 2nd half of year	384
4Xqrs5Y	mobile	1	101	0/1094	0	H1_H2 qrsallgears	ALK made up from all gears for entire year for 4Xqrs5Y, LF from 2nd quarter	288
4Xqrs5Y	mobile	2	214	1094	114	H1_H2 qrsallgears	ALK made up from all gears for entire year for 4Xqrs5Y	288
4Xqrs5Y	mobile	3	87	1011	104	H1_H2 qrsallgears	ALK made up from all gears for entire year for 4Xqrs5Y	288
4Xqrs5Y	mobile	4	32	239	22	H1_H2 qrsallgears	ALK made up from all gears for entire year for 4Xqrs5Y	288
4Xqrs5Y	fixed	1	2	1344	27	H1_H2 qrsallgears	ALK made up from all gears for entire year for 4Xqrs5Y, LF from 2nd quarter	288
4Xqrs5Y	fixed	2	4	0/1344	0	H1_H2 qrsallgears	ALK made up from all gears for entire year for 4Xqrs5Y	288
4Xqrs5Y	fixed	3	43	230	21	H1_H2 qrsallgears	ALK made up from all gears for entire year for 4Xqrs5Y, LF from 3rd quarter	288
4Xqrs5Y	fixed	4	7	0/230	0	H1_H2 qrsallgears	ALK made up from all gears for entire year for 4Xqrs5Y, LF from 3rd quarter	288

Table 7. Commercial catch at age (000's) of 4X5Y haddock. Separate annual a's and b's were applied for landings from 4Xmnop and 4Xqrs5Y (ages 1-16, years 1970-2010).

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	0	0	42	152	1	37	18	2	0	0	16	1	0	0	2	0	0	0	13	13	0
2	1088	809	22	3114	713	2198	1306	1289	77	83	164	1210	526	70	763	228	294	90	214	190	313
3	747	1660	3490	114	4783	4617	1657	3137	3453	1184	2497	2268	3895	3621	1195	2105	1153	1043	512	497	1189
4	1549	809	1871	2274	318	5220	4295	2026	7221	6862	3071	6369	2648	6020	5046	2455	4871	3030	1016	499	370
5	391	1460	517	1080	1829	490	3712	3204	2156	3970	5527	4300	4954	4104	3708	4658	4021	4588	896	936	461
6	541	415	656	533	523	1115	437	2891	2916	1094	3573	3272	1823	2454	2583	1508	1512	2096	1968	310	459
7	4679	71	91	607	194	250	813	361	1071	1272	538	1191	1560	1033	1022	509	226	291	871	720	512
8	1922	3404	58	326	277	174	155	390	141	269	636	366	364	434	367	136	98	58	894	460	628
9	137	1047	1185	262	191	63	72	107	110	58	173	331	196	206	119	51	36	7	372	504	299
10	99	167	520	621	277	32	96	72	27	70	35	99	101	131	83	16	31	9	209	255	211
11	181	186	26	56	567	167	39	23	9	11	21	14	48	76	39	7	11	6	146	57	55
12	28	150	196	13	25	231	104	8	6	1	3	24	17	27	22	4	6	0	49	81	50
13	38	108	93	6	4	11	158	87	49	18	10	9	15	27	13	2	3	0	44	30	14
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	0	22	12	9
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	4	5
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	3

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	3	8	29	24	3	0	0	0	0	0	0	1	0	0	1	0	1	0	6	0
2	18	164	139	113	92	24	15	39	38	257	100	46	28	15	34	62	234	149	41	24
3	1163	224	567	404	830	912	340	109	462	448	1654	415	673	277	64	923	479	415	379	63
4	2553	2589	495	564	667	1088	1807	947	563	819	1053	2520	1551	990	482	285	4468	638	562	761
5	585	2272	1790	312	738	638	1012	1804	1237	558	776	713	2870	1198	1541	679	293	2356	653	551
6	261	276	1199	974	192	514	478	1188	941	1289	646	563	651	1868	1163	1081	381	368	1747	697
7	340	238	205	306	438	397	269	576	598	980	1326	511	353	553	972	747	713	334	458	1664
8	248	250	111	34	471	523	140	410	230	556	923	752	286	258	320	531	409	579	234	401
9	305	153	139	14	195	478	192	141	55	224	379	529	230	201	111	174	337	342	350	170
10	260	300	45	14	40	138	133	220	49	111	124	248	167	171	86	25	77	209	219	345
11	168	90	53	23	27	18	54	114	54	39	25	114	52	58	72	32	50	91	114	154
12	146	126	41	11	19	1	41	27	25	9	16	61	22	32	26	6	6	22	28	114
13	55	34	17	4	7	1	3	5	5	11	4	16	11	19	1	4	10	26	18	18
14	9	18	11	1	11	3	1	11	0	6	15	3	0	4	0	3	1	1	4	11
15	6	4	1	0	5	1	0	7	0	5	0	2	0	0	0	0	0	0	0	0
16	7	1	0	2	2	4	7	3	0	0	0	1	0	0	12	0	0	0	0	0

Table 8. Commercial weight at age (kg) of 4X5Y haddock from ages 1-16 during years 1970-2010 and overall mean weight at age. No observations indicated by dashes (ages 1-16, years 1970-2010).

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	0.29	0.29	0.29	0.27	0.18	0.23	0.23	0.28	0.29	0.29	0.16	0.23	-	-	0.25	-	-	-	0.439	-	-
2	0.57	0.5	0.45	0.51	0.46	0.52	0.52	0.46	0.44	0.51	0.522	0.593	0.493	0.394	0.527	0.573	0.522	0.615	0.848	0.81	0.666
3	0.9	0.96	0.9	0.75	0.82	0.82	0.81	0.71	0.87	0.87	0.882	0.877	0.907	0.758	0.785	0.83	0.728	0.779	1.085	1.085	1.073
4	1.05	1.25	1.35	1.25	1.1	1.2	1.19	1.22	1.33	1.33	1.326	1.26	1.294	1.141	1.069	1.071	1.022	1.005	1.179	1.232	1.431
5	1.16	1.4	1.6	1.8	1.7	1.55	1.6	1.72	1.85	1.84	1.777	1.721	1.653	1.714	1.411	1.408	1.38	1.328	1.469	1.35	1.809
6	1.43	1.5	1.75	2	2.3	2.25	2.1	2.2	2.33	2.36	2.355	2.219	2.13	2.146	1.932	1.966	1.838	1.796	1.522	1.511	1.74
7	1.65	1.75	1.9	2.2	2.5	2.85	2.95	2.94	2.7	2.83	2.906	2.654	2.577	2.607	2.287	2.442	2.506	2.472	1.683	1.69	2.001
8	1.95	1.95	2.1	2.3	2.6	3	3.5	3.3	3.39	3.3	3.278	3.134	2.947	2.869	2.683	2.92	2.775	3.123	1.794	1.672	2.05
9	2.3	2.3	2.3	2.5	2.8	3.2	3.6	3.57	3.77	4.03	3.811	3.608	3.47	3.108	3.054	3.501	3.396	4.061	2.031	1.815	2.108
10	2.82	2.65	2.8	2.7	2.95	3.45	3.8	3.77	4.17	4.15	4.332	3.688	4.033	3.55	3.431	3.313	3.493	3.309	2.256	1.882	2.351
11	2.8	3.25	3	3.3	3.2	3.5	4.1	3.69	4.03	4.96	4.2	4.546	3.946	3.63	3.841	4.029	3.299	4.15	2.373	2.256	2.316
12	2.85	3	3.7	3.4	3.8	3.7	4	3.94	3.62	6	4.963	4.823	4.033	3.78	4.114	4.424	3.331	4.775	2.57	2.379	2.613
13	3.6	3	3.3	4.2	3.9	4.4	4.2	3.91	4.63	5.68	5.711	4.68	4.908	4.064	4	5.468	4.286	5.173	2.329	2.49	2.373
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.595	4.804	5.827	3.302	2.713	3.126
15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.767	3.135	3.204
16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.526	4.754	6.052	4.546

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Mean
1	0.55	0.671	-	-	0.161	-	-	-	-	-	-	0.284	-	-	0.192	-	0.170	-	0.487	-	0.338
2	1.159	0.79	0.796	0.872	0.773	0.906	0.827	0.611	0.965	0.798	0.752	0.824	0.917	0.478	0.560	0.792	0.719	0.652	0.629	0.616	0.782
3	1.104	1.026	0.972	1.139	1.074	1.011	1.03	0.922	1.176	0.947	1.001	1.046	1.076	0.815	0.693	0.780	0.705	0.777	0.69	0.755	0.967
4	1.44	1.232	1.129	1.312	1.369	1.217	1.289	1.029	1.436	1.193	1.096	1.225	1.199	0.972	0.800	0.853	0.872	0.855	0.977	0.843	1.155
5	1.833	1.572	1.392	1.483	1.597	1.396	1.561	1.23	1.407	1.274	1.217	1.317	1.422	0.980	1.061	0.942	0.853	0.989	1.085	1.027	1.333
6	2.016	1.956	1.734	1.793	1.73	1.598	1.869	1.429	1.62	1.32	1.216	1.328	1.427	1.231	1.127	1.153	1.007	0.919	1.214	1.132	1.485
7	2.088	1.887	2.132	2.08	1.976	1.614	2.048	1.676	1.966	1.532	1.318	1.367	1.443	1.346	1.318	1.138	1.119	0.990	1.273	1.239	1.634
8	2.234	1.963	2.098	2.493	2.013	1.86	2.069	1.88	2.198	1.776	1.502	1.399	1.493	1.459	1.399	1.246	1.101	1.046	1.338	1.253	1.752
9	2.24	2.158	2.365	2.101	2.355	2.136	2.199	2.08	2.1	2.201	1.696	1.601	1.473	1.366	1.653	1.288	1.155	1.070	1.251	1.276	1.860
10	2.228	2.167	2.242	2.775	2.286	2.042	2.357	2.122	2.154	2.45	2.094	1.852	1.822	1.574	1.693	1.416	1.405	1.226	1.266	1.181	2.013
11	2.274	2.1	2.377	2.204	2.584	2.75	2.648	2.433	2.678	2.09	2.41	2.074	2.278	1.866	1.616	1.507	1.310	1.222	1.311	1.393	2.144
12	2.339	1.968	2.148	2.381	2.305	3.373	2.55	2.939	2.49	3.405	2.484	1.828	2.486	1.858	1.811	1.913	1.729	1.471	1.524	1.37	2.321
13	2.327	2.66	2.521	2.899	2.623	3.027	3.072	3.537	2.141	2.525	2.579	3.177	2.576	2.001	2.937	2.184	1.201	1.314	1.25	1.688	2.509
14	2.654	2.919	2.887	4.51	2.902	3.271	4.481	3.604	5.7	3.477	1.788	4.459	-	2.946	-	2.029	1.995	1.803	2.3	1.446	3.209
15	3.421	3.218	4.777	4.308	3.095	3.49	-	2.348	5.184	2.645	3.167	4.737	-	-	-	-	-	-	-	-	3.633
16	3.787	5.541	5.628	2.486	3.224	3.286	3.674	3.081	-	-	-	5.56	-	-	1.111	-	-	3.894	-	2.13	3.818

Table 9. Commercial weight at age (kg) of 4X5Y haddock for 2004-2010, ages 1-16, calculated separately for areas 4xmnop and 4qrs5Y.

A. Commercial weight at age (kg) for area 4Xmnop.

Age	2004	2005	2006	2007	2008	2009	2010
1	-	0.192	-	-	-	-	-
2	0.325	0.570	0.877	0.622	0.436	0.502	0.458
3	0.871	0.618	0.726	0.653	0.693	0.651	0.704
4	0.944	0.747	0.820	0.857	0.839	0.966	0.829
5	0.889	1.042	0.891	0.833	0.966	1.092	1.026
6	1.150	1.039	1.157	0.976	0.915	1.224	1.139
7	1.306	1.212	1.061	1.105	0.976	1.269	1.238
8	1.421	1.305	1.201	1.063	1.026	1.336	1.261
9	1.325	1.603	1.238	1.093	1.048	1.239	1.267
10	1.659	1.663	1.407	1.303	1.129	1.256	1.178
11	1.819	1.513	1.512	1.261	1.137	1.300	1.390
12	1.748	1.684	1.861	1.729	1.452	1.477	1.366
13	1.987	3.092	2.045	1.201	1.314	1.250	1.768
14	2.946	-	1.725	1.995	1.803	2.596	1.446
15	-	-	-	-	-	-	-
16	-	-	-	-	-	-	2.135

B. Commercial weight at age (kg) for area 4qrs5Y.

Age	2004	2005	2006	2007	2008	2009	2010
1	-	-	-	0.170	-	0.487	-
2	0.514	0.285	0.561	0.749	0.760	0.761	0.709
3	0.774	1.057	0.847	0.884	0.971	0.845	1.039
4	1.033	0.942	0.941	0.971	1.013	1.043	0.918
5	1.111	1.203	1.089	0.957	1.121	0.996	1.030
6	1.362	1.318	1.131	1.153	0.970	1.158	1.031
7	1.489	1.512	1.387	1.244	1.097	1.350	1.250
8	1.561	1.790	1.390	1.340	1.283	1.356	1.134
9	1.830	2.047	1.778	1.656	1.245	1.466	1.835
10	1.407	1.917	2.043	2.024	1.718	2.207	1.258
11	2.203	2.322	1.407	1.721	1.861	1.900	1.501
12	2.239	2.667	4.409	-	2.031	1.996	1.753
13	2.181	2.686	2.950	-	-	-	1.406
14	-	-	2.688	-	-	1.799	-
15	-	-	-	-	-	-	-
16	-	-	-	-	3.894	-	-

Table 10. Total numbers at age (000's) of 4X5Y haddock in the summer RV survey (ages 1-13, years 1970-2010).

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	8142	165	7425	8948	15487	9471	7557	9044	8134	2798	27001	38643	12505	5860	5619	9511	4184	1796	9953	8449	107
2	6550	15854	327	32353	32490	5090	9216	57182	7432	19505	9929	39969	39456	6026	33711	13649	13421	2141	3017	13828	15039
3	1915	6888	4788	1034	46947	7600	5928	89094	17221	11665	21879	9658	18728	20262	17166	32716	10615	3855	1438	2765	13520
4	3615	3043	2170	4543	1438	11228	6201	25359	5879	14866	11254	13254	7432	8964	26029	15005	21302	4763	2940	1296	2491
5	1466	4241	1281	2136	5880	584	10452	24567	2441	7510	17467	5396	12091	5288	8177	20684	8342	5763	4167	2606	2014
6	3364	2020	1409	758	1313	2545	918	13536	4692	3148	6744	5979	4937	3331	4177	5308	8900	4015	4412	1110	2233
7	8660	3126	921	1108	770	646	1138	1845	1863	4701	2437	1900	5397	1374	2005	2636	3179	2924	2114	2307	2036
8	1232	8633	1442	812	921	485	206	2220	120	2032	1830	250	935	485	856	1675	1637	1273	1647	825	1702
9	494	1114	2272	539	508	202	108	256	0	347	927	475	595	458	564	921	929	382	1020	688	711
10	470	131	78	890	366	166	28	221	0	162	360	277	333	330	132	339	532	453	565	203	579
11	111	61	9	35	552	529	13	29	65	0	54	122	220	265	46	98	89	103	185	164	287
12	28	160	8	0	0	410	215	237	50	0	0	61	0	83	47	46	151	22	22	129	129
13	0	0	19	20	0	0	152	120	31	0	0	0	0	85	56	46	97	0	0	0	84

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	6014	4418	6551	30025	65744	7124	14188	14127	51122	38697	43613	5986	3317	11651	3365	9539	14461	961	2007	5259
2	1950	3527	1501	8397	35234	38001	8328	10919	28975	63060	45158	24017	7516	5254	21234	5163	15744	19145	1899	3203
3	17855	1379	2473	3117	16710	35704	30275	6704	13702	9735	58527	32706	20246	7652	5056	21094	7266	8983	22183	1586
4	16311	10876	942	2792	5933	18176	18268	19686	9190	6743	17149	36171	22433	15912	7306	7640	25721	6292	12096	12893
5	3420	7730	2706	564	2693	7349	5655	10591	15602	5475	6528	8609	19375	11900	12913	4664	3742	16109	7070	6387
6	1886	1482	1634	2751	1097	2414	2361	2706	8693	7562	3116	4509	3689	10059	12368	10719	4477	2052	13719	6623
7	1670	545	268	1602	2254	1688	863	2187	4273	2687	7957	3282	4107	3494	7104	6646	9176	2249	3186	9388
8	1428	563	199	213	586	2356	263	1423	1644	1068	3071	4998	2379	2134	3528	9327	5694	4967	3262	4870
9	1054	413	81	74	145	576	448	400	1240	472	1695	2696	4077	790	1149	2059	3559	3806	5835	2014
10	1254	305	68	121	0	477	276	249	274	94	1149	1431	1497	920	1042	1478	859	2176	5463	1512
11	126	59	145	15	0	191	30	178	267	33	124	982	622	423	512	884	685	1324	1457	1021
12	121	24	31	79	30	35	14	21	172	20	0	43	0	172	189	184	127	96	524	581
13	27	6	41	141	0	105	0	0	65	0	48	56	53	12	0	7	68	187	0	296

Table 11. Mean weight at age (kg) of 4X5Y haddock in the summer RV survey (ages 1-13, years 1970-2010).

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	0.08	0.10	0.08	0.09	0.09	0.10	0.09	0.10	0.07	0.08	0.07	0.08	0.05	0.04	0.08	0.07	0.05	0.09	0.09	0.09	0.11
2	0.39	0.25	0.20	0.30	0.31	0.37	0.37	0.46	0.41	0.35	0.44	0.40	0.22	0.24	0.29	0.33	0.29	0.34	0.52	0.36	0.42
3	0.76	0.76	0.66	0.51	0.71	0.76	0.70	0.84	0.90	0.78	0.79	0.86	0.68	0.55	0.47	0.55	0.60	0.58	0.69	0.75	0.82
4	1.08	1.08	1.30	1.35	1.01	1.27	1.16	1.26	1.47	1.37	1.31	1.20	1.31	1.10	0.84	0.73	0.78	0.97	0.99	0.91	1.34
5	1.38	1.42	1.63	1.82	1.72	1.80	1.52	1.77	1.95	1.76	1.75	1.86	1.70	1.59	1.27	1.01	1.02	1.15	1.35	1.29	1.69
6	1.61	1.62	1.99	2.37	2.22	2.27	1.93	2.01	2.26	2.38	2.11	2.31	2.33	1.89	1.85	1.38	1.18	1.14	1.38	1.51	1.88
7	2.03	1.72	2.15	2.40	2.52	2.83	2.41	2.87	2.64	2.71	2.50	2.76	2.87	2.38	2.07	2.02	1.43	1.44	1.65	1.54	2.13
8	2.34	2.18	2.50	2.46	2.68	3.01	2.38	2.92	3.42	3.37	2.71	3.11	3.34	2.67	2.45	1.98	1.69	1.66	1.65	1.61	2.19
9	2.38	2.59	2.90	2.72	2.78	3.25	2.69	4.02	4.03	3.45	3.31	3.45	2.82	2.83	1.94	2.17	2.09	1.99	1.56	2.53	2.01
10	2.95	4.07	3.97	2.89	2.82	3.17	2.60	2.97	3.48	3.32	3.97	4.21	3.18	3.77	2.48	2.20	1.82	1.90	1.80	1.64	1.68
11	3.63	3.52	3.70	3.39	3.41	3.31	3.50	3.50	2.60	3.40	3.81	4.47	3.15	2.35	2.64	2.80	2.33	2.20	2.31	2.45	3.51
12	2.23	4.74	4.60	3.33	3.06	3.53	4.20	4.00	3.69	3.50	3.20	2.84	6.00	2.90	1.31	2.48	2.56	2.76	2.00	1.27	1.51
13	6.20	4.00	3.37	3.63	3.90	4.37	2.30	3.10	2.12	3.51	3.56	3.50	1.68	2.18	3.88	1.35	1.45	2.43	2.80	1.30	1.77

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	0.08	0.08	0.10	0.14	0.06	0.05	0.11	0.07	0.10	0.11	0.09	0.08	0.07	0.09	0.08	0.09	0.08	0.10	0.12	0.14
2	0.60	0.31	0.37	0.42	0.35	0.21	0.23	0.26	0.19	0.39	0.24	0.21	0.22	0.18	0.24	0.18	0.20	0.31	0.34	0.32
3	0.84	0.62	0.77	0.87	0.83	0.68	0.43	0.41	0.54	0.57	0.54	0.40	0.36	0.46	0.41	0.45	0.44	0.46	0.50	0.59
4	1.33	1.14	1.11	1.23	1.16	1.21	0.79	0.62	0.61	0.89	0.64	0.64	0.67	0.57	0.61	0.49	0.71	0.63	0.67	0.70
5	1.50	1.67	1.39	1.34	1.44	1.45	1.19	1.07	0.82	0.80	0.93	0.71	1.08	0.70	0.66	0.64	0.78	0.73	0.76	0.80
6	2.08	2.01	1.78	1.66	1.54	1.78	1.39	1.45	0.97	1.01	0.93	0.92	1.05	0.87	0.77	0.81	0.89	0.89	1.02	0.96
7	2.06	2.30	1.94	1.93	1.79	1.88	1.65	1.79	1.17	1.33	1.04	0.98	1.11	0.95	0.94	0.87	0.94	0.99	0.93	1.10
8	2.12	1.76	1.86	2.32	2.20	1.90	1.90	2.14	1.31	1.57	1.21	0.99	1.13	0.92	0.99	0.92	1.13	0.91	0.96	1.02
9	2.00	1.40	1.57	2.65	2.50	1.90	2.02	1.37	1.99	1.42	1.15	1.29	1.04	1.14	1.16	1.15	1.34	1.02	1.12	1.02
10	2.54	2.23	1.71	2.45	1.54	1.58	1.89	2.46	1.14	1.17	1.32	1.13	1.10	1.03	1.42	1.32	1.05	1.33	1.12	1.02
11	2.79	2.19	2.20	2.23	2.05	2.17	1.81	1.86	1.64	0.91	1.44	1.31	1.13	1.20	1.42	1.32	1.05	1.33	1.12	1.02
12	2.02	1.36	1.47	1.64	2.20	1.89	1.80	1.20	0.99	1.42	1.32	1.05	1.33	1.12	1.06	1.32	1.05	1.33	1.12	1.02
13	1.42	1.32	1.05	1.33	1.12	1.02	1.80	1.20	0.99	1.42	1.32	1.05	1.33	1.12	1.06	1.32	1.05	1.33	1.12	1.02

Table 12. Mean numbers per tow of 4X5Y haddock in the ITQ survey (ages 1-13, years 1996-2010).

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	6.9	14.7	14.9	98.8	75.6	58.9	17.3	6.2	38.6	7.2	20.3	48.8	2.5	2.4	25.9
2	41.3	9.5	29.3	39.7	75.1	54.5	29.3	17.1	12.8	35.9	8.7	47.1	43.8	3.4	8.5
3	25.1	33.1	8.3	18.2	11.7	56.5	30.4	30.6	12.3	4.1	23.7	14.3	18.3	16.6	2.3
4	9.0	19.4	21.5	7.1	7.5	13.5	29.9	26.3	16.1	4.7	7.2	34.8	7.3	6.5	11.2
5	3.5	5.0	8.0	11.1	7.0	5.0	6.5	13.9	10.0	7.7	3.5	4.0	15.9	3.1	4.6
6	0.9	1.6	1.2	4.6	7.6	2.1	3.0	2.4	6.9	6.9	6.4	4.0	1.3	5.4	3.6
7	0.7	0.6	0.8	2.1	2.4	5.3	2.2	2.4	2.2	3.6	3.8	7.6	1.5	1.6	4.3
8	0.8	0.2	0.4	0.6	0.9	1.9	3.0	1.2	1.3	1.8	4.8	4.47	3.26	1.4	2.5
9	0.2	0.3	0.2	0.5	0.3	1.0	1.6	2.0	0.6	0.6	0.8	2.84	2.46	2.5	1.1
10	0.2	0.2	0.2	0.1	0.1	0.7	0.9	0.8	0.6	0.5	0.7	0.67	1.4	2.1	0.8
11	0.0	0.0	0.1	0.1	0.0	0.1	0.8	0.3	0.3	0.2	0.4	0	0	0	0
12	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0	0	0	0
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0	0	0	0	0

Table 13. Population numbers generated by SPA model for 4X5Y haddock (ages 1-13, years 1970-2010).

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1	26014	6675	48064	44954	24331	49817	54488	31445	43742	32841
2	12270	21298	5465	39313	36667	19920	40753	44594	25743	35813
3	5982	9062	16705	4454	29369	29376	14320	32184	35345	21007
4	7980	4222	5917	10519	3544	19718	19873	10225	23512	25813
5	3962	5132	2724	3151	6555	2614	11420	12384	6538	12716
6	4681	2890	2881	1763	1603	3712	1697	5991	7240	3402
7	17386	3343	1991	1765	961	839	2030	994	2289	3289
8	4792	10001	2673	1547	896	611	461	926	487	905
9	493	2184	5108	2136	972	483	343	237	406	271
10	725	279	841	3110	1511	623	338	216	97	233
11	586	504	78	218	1984	987	481	190	111	55
12	271	316	244	40	128	1112	657	359	135	83
13	315	196	123	22	21	82	701	444	286	105
Sum	85456	66102	92814	112994	108543	129892	147562	140189	145932	136533

Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	41104	45040	33103	41305	15987	11351	6251	7892	24820	22040
2	26888	33639	36874	27102	33817	13087	9293	5118	6462	20309
3	29246	21865	26446	29714	22126	26997	10509	7343	4108	5097
4	16128	21685	15850	18128	21052	17034	20199	7561	5068	2900
5	14925	10426	11991	10581	9395	12670	11725	12130	3448	3230
6	6819	7219	4645	5335	4949	4337	6158	5961	5780	2013
7	1796	2350	2949	2153	2148	1715	2186	3674	2984	2951
8	1542	983	846	1003	828	834	943	1585	2745	1655
9	498	687	474	363	429	346	559	684	1245	1438
10	169	251	263	211	111	243	237	425	553	683
11	127	107	116	124	54	16	185	166	340	264
12	35	85	75	52	33	9	7	141	131	146
13	67	26	48	46	18	7	4	0	116	63
Sum	139344	144362	133681	136117	110947	88645	68256	52680	57801	62790

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1	6699	10666	11967	19259	25690	21961	13102	12739	14779	37375
2	18033	5485	8730	9791	15742	21011	17977	10727	10430	12100
3	16456	14481	4474	6999	7890	12786	17119	14697	8769	8504
4	3723	12397	10804	3461	5218	6094	9717	13191	11725	7081
5	1923	2714	7840	6503	2385	3761	4386	6971	9165	8743
6	1797	1157	1692	4363	3704	1671	2412	3014	4792	5871
7	1367	1056	711	1136	2487	2152	1194	1510	2035	2848
8	1765	656	557	367	744	1759	1365	618	993	1145
9	939	877	313	230	200	579	1014	644	380	442
10	721	498	442	118	63	151	297	398	354	183
11	329	400	173	90	56	39	88	119	205	91
12	165	219	175	60	26	25	7	55	48	65
13	47	90	47	30	12	11	3	5	8	15
Sum	53964	50696	47926	52406	64217	72000	68683	64689	63683	84463

Table 13. Continued.

Age	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	26225	33097	14815	14225	57724	18892	24083	32293	3827	7080	21543
2	30600	21471	27098	12128	11646	47261	15466	19718	26439	3133	5791
3	9872	24821	17489	22144	9905	9523	38663	12607	15932	21515	2528
4	6545	7677	18825	13943	17521	7872	7747	30820	9888	12694	17272
5	5288	4617	5333	13132	10012	13466	6118	6085	21190	7532	9884
6	6039	3825	3078	3721	8155	7137	9732	4394	4716	15319	5576
7	3955	3778	2547	2011	2457	5031	4988	6990	3253	3534	10961
8	1791	2352	1893	1623	1327	1482	3314	3603	5077	2345	2479
9	729	963	1090	870	1070	830	666	2555	2580	3595	1708
10	312	394	446	414	504	670	391	522	1787	1758	2628
11	106	155	211	141	188	264	430	302	358	1248	1241
12	25	51	104	69	68	98	147	343	202	208	919
13	31	13	28	30	37	17	56	117	276	138	145
Sum	91517	103214	92955	84450	120614	112541	111799	120349	95525	80098	82675

Table 14. Estimates of fishing mortality (F) generated by SPA model for 4X5Y haddock (ages 1-13, years 1970-2010; Avg 6-9: averaged F for ages 6-9).

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	0	0	0	0	0	0	0	0	0	0	0
2	0.1	0.04	0	0.09	0.02	0.13	0.04	0.03	0	0	0.01
3	0.15	0.23	0.26	0.03	0.2	0.19	0.14	0.11	0.11	0.06	0.1
4	0.24	0.24	0.43	0.27	0.1	0.35	0.27	0.25	0.41	0.35	0.24
5	0.12	0.38	0.24	0.48	0.37	0.23	0.45	0.34	0.45	0.42	0.53
6	0.14	0.17	0.29	0.41	0.45	0.4	0.34	0.76	0.59	0.44	0.87
7	0.35	0.02	0.05	0.48	0.25	0.4	0.58	0.51	0.73	0.56	0.4
8	0.59	0.47	0.02	0.27	0.42	0.38	0.46	0.63	0.39	0.4	0.61
9	0.37	0.75	0.3	0.15	0.24	0.16	0.26	0.69	0.36	0.27	0.48
10	0.16	1.08	1.15	0.25	0.23	0.06	0.38	0.46	0.37	0.4	0.26
11	0.42	0.52	0.46	0.33	0.38	0.21	0.09	0.14	0.09	0.25	0.2
12	0.12	0.74	2.19	0.44	0.24	0.26	0.19	0.02	0.05	0.01	0.1
13	0.14	0.91	1.67	0.35	0.23	0.16	0.28	0.24	0.21	0.21	0.18
Avg 6-9	0.36	0.36	0.17	0.32	0.34	0.33	0.41	0.65	0.51	0.42	0.59

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	0	0	0	0	0	0	0	0	0	0	0
2	0.04	0.02	0	0.03	0.02	0.04	0.02	0.04	0.01	0.02	0
3	0.12	0.18	0.14	0.06	0.09	0.13	0.17	0.15	0.11	0.08	0.09
4	0.39	0.2	0.46	0.31	0.17	0.31	0.59	0.25	0.21	0.12	0.26
5	0.61	0.61	0.56	0.57	0.52	0.48	0.54	0.34	0.39	0.31	0.27
6	0.7	0.57	0.71	0.86	0.49	0.32	0.49	0.47	0.19	0.33	0.29
7	0.82	0.88	0.76	0.75	0.4	0.12	0.09	0.39	0.31	0.53	0.44
8	0.53	0.65	0.65	0.67	0.2	0.12	0.04	0.45	0.37	0.5	0.54
9	0.76	0.61	0.99	0.37	0.18	0.07	0.01	0.4	0.49	0.43	0.49
10	0.57	0.55	1.16	1.75	0.08	0.16	0.02	0.54	0.53	0.39	0.86
11	0.16	0.61	1.13	1.6	0.67	0.07	0.04	0.64	0.27	0.2	0.62
12	0.37	0.29	0.87	1.36	0.69	3.99	0	0.54	0.95	0.41	1.33
13	0.47	0.42	1.01	1.55	0.38	2.08	0.01	0.54	0.74	0.4	1.1
Avg 6-9	0.70	0.68	0.78	0.66	0.31	0.16	0.16	0.43	0.34	0.45	0.44

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	0	0	0	0	0	0	0	0	0	0	0
2	0.02	0.02	0.01	0	0	0	0	0	0.01	0.01	0
3	0.06	0.09	0.06	0.07	0.06	0.03	0.01	0.06	0.05	0.08	0.03
4	0.31	0.17	0.13	0.13	0.13	0.16	0.09	0.09	0.15	0.16	0.16
5	0.39	0.36	0.16	0.24	0.18	0.17	0.25	0.17	0.12	0.21	0.16
6	0.2	0.36	0.34	0.14	0.27	0.19	0.32	0.19	0.27	0.21	0.23
7	0.46	0.22	0.15	0.25	0.46	0.22	0.38	0.26	0.32	0.49	0.25
8	0.68	0.41	0.05	0.35	0.55	0.29	0.61	0.25	0.42	0.57	0.58
9	0.78	1.1	0.08	0.47	0.74	0.4	0.53	0.15	0.41	0.57	0.77
10	1.39	0.55	0.28	0.35	0.72	0.46	1.16	0.35	0.5	0.43	0.95
11	0.86	1.05	0.61	1.49	0.26	0.7	0.95	1.07	0.52	0.2	0.91
12	1.58	1.41	0.63	1.89	0.17	1.7	0.96	0.55	0.5	0.42	1.04
13	1.49	0.98	0.46	1.12	0.44	1.08	1.06	0.45	0.5	0.42	1.0
Avg 6-9	0.53	0.52	0.16	0.3	0.5	0.27	0.46	0.21	0.36	0.46	0.46

Table 14. Continued.

Age	2003	2004	2005	2006	2007	2008	2009	2010
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0.01	0.01	0.01	0
3	0.03	0.03	0.01	0.03	0.04	0.03	0.02	0.03
4	0.13	0.06	0.05	0.04	0.17	0.07	0.05	0.05
5	0.28	0.14	0.12	0.13	0.05	0.12	0.1	0.06
6	0.21	0.28	0.16	0.13	0.1	0.09	0.13	0.15
7	0.22	0.31	0.22	0.13	0.12	0.13	0.15	0.18
8	0.22	0.27	0.6	0.06	0.13	0.15	0.12	0.2
9	0.35	0.27	0.55	0.04	0.16	0.18	0.11	0.12
10	0.59	0.45	0.24	0.06	0.18	0.16	0.15	0.16
11	0.53	0.45	0.39	0.03	0.2	0.34	0.11	0.15
12	0.43	1.2	0.36	0.02	0.02	0.18	0.16	0.15
13	0.51	0.82	0.3	0.04	0.1	0.17	0.15	0.15
Avg 6-9	0.25	0.28	0.38	0.09	0.13	0.14	0.13	0.16

Table 15. Biomass estimates generated by SPA model for 4X5Y haddock (ages 1-13, years 1970-2010). Sum of ages 4-13 represents SSB.

Age	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	1182	303	3475	1800	1221	2104	2930	1248	2250	970	1455
2	3450	3000	786	5974	6182	3569	7885	9103	5310	5445	5107
3	3816	4952	6764	1433	13445	14226	7252	17848	22816	11931	15297
4	7485	3833	5896	9926	2546	18668	18647	9561	26051	28653	16307
5	5071	6359	3623	4848	9966	3528	15858	17751	10243	20401	23115
6	7269	4325	4851	3471	3217	7327	3159	10480	14485	7336	13132
7	34126	5559	3709	3855	2349	2102	4750	2336	5273	8139	4379
8	10638	21059	5545	3558	2270	1683	1099	2457	1526	2700	4180
9	898	5374	12840	5567	2546	1425	921	734	1391	931	1647
10	1959	870	2695	8972	4182	1850	880	609	338	772	627
11	1864	1622	287	738	6222	3015	1602	573	290	188	452
12	449	1312	981	133	391	3856	2451	1342	485	251	113
13	1706	585	416	81	76	300	1612	1375	607	369	237
Sum 4-13	71465	50898	40842	41149	33763	43753	50979	47218	60688	69739	64188

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	1403	1440	857	238	472	231	165	976	1031	273	496
2	5755	4769	2884	3642	2169	1340	689	1421	3675	3503	1403
3	13482	13789	10406	7407	10772	4695	2988	1994	3177	8886	8637
4	21163	16862	15677	14275	9911	13184	5776	3838	2298	3722	12944
5	16285	17119	15251	11132	11642	10089	11479	3939	3647	2386	3848
6	14528	9670	9545	8471	5748	6717	6416	7304	2871	2801	2172
7	5673	7596	5069	4246	3315	3072	4778	4096	4313	2453	2080
8	2739	2570	2674	2000	1648	1597	2443	4218	2668	3242	1393
9	2101	1336	1028	830	752	1137	1255	1937	2935	1688	1757
10	937	836	687	276	502	431	810	996	1092	1211	1123
11	451	365	291	142	42	418	332	713	554	789	865
12	241	388	149	43	22	17	358	261	187	249	443
13	87	81	100	60	9	5	0	322	82	70	127
Sum 4-13	64205	56822	50471	41475	33591	36668	33647	27623	20647	18611	26751

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1	516	748	1212	1384	452	323	961	1428	1403	2423	832
2	1394	1696	3205	4654	2068	1187	1799	1338	6186	3421	3654
3	2738	3403	4440	7571	8387	4406	2695	3193	3229	11455	5335
4	10571	2879	5086	6097	9732	9686	6045	3525	4532	4640	11044
5	11674	8201	2909	5007	5681	8275	8438	6239	3686	4185	3603
6	2941	7507	5630	2398	3856	4195	6282	5671	5504	3308	2816
7	1557	2205	4601	3708	2028	2488	3212	3335	4487	3877	2435
8	981	683	1579	3619	2518	1169	1862	1504	2431	2848	1880
9	437	360	444	1394	1922	1263	521	879	998	1105	1362
10	933	182	123	232	470	752	789	210	364	519	501
11	378	198	109	79	160	201	382	149	96	201	275
12	238	88	43	54	13	100	58	64	36	56	109
13	63	31	16	13	3	9	10	15	36	17	29
Sum 4-13	29773	22333	20539	22602	26385	28138	27600	21592	22170	20756	24055

Table 15. Continued.

Age	2003	2004	2005	2006	2007	2008	2009	2010
1	668	2447	1015	1284	1937	142	384	1553
2	1571	1270	6811	1856	2604	4018	578	1118
3	6040	3105	2544	12544	3536	4763	8477	1136
4	7182	7886	4150	3464	17318	5176	7032	10259
5	10855	6871	8258	3810	3769	15276	5206	7271
6	3207	7070	5254	7138	3311	3942	13235	4779
7	2025	2330	4544	4085	6111	3053	3220	11604
8	1710	1222	1436	3062	3566	4641	2246	2411
9	884	1217	859	709	2844	2642	3642	1685
10	453	518	855	485	549	2372	1885	2670
11	158	215	319	568	317	423	1401	1261
12	91	76	104	193	360	239	234	933
13	36	41	18	66	123	325	155	147
Sum 4-10	26602	27447	25797	23581	38269	38088	38258	43019

FIGURES

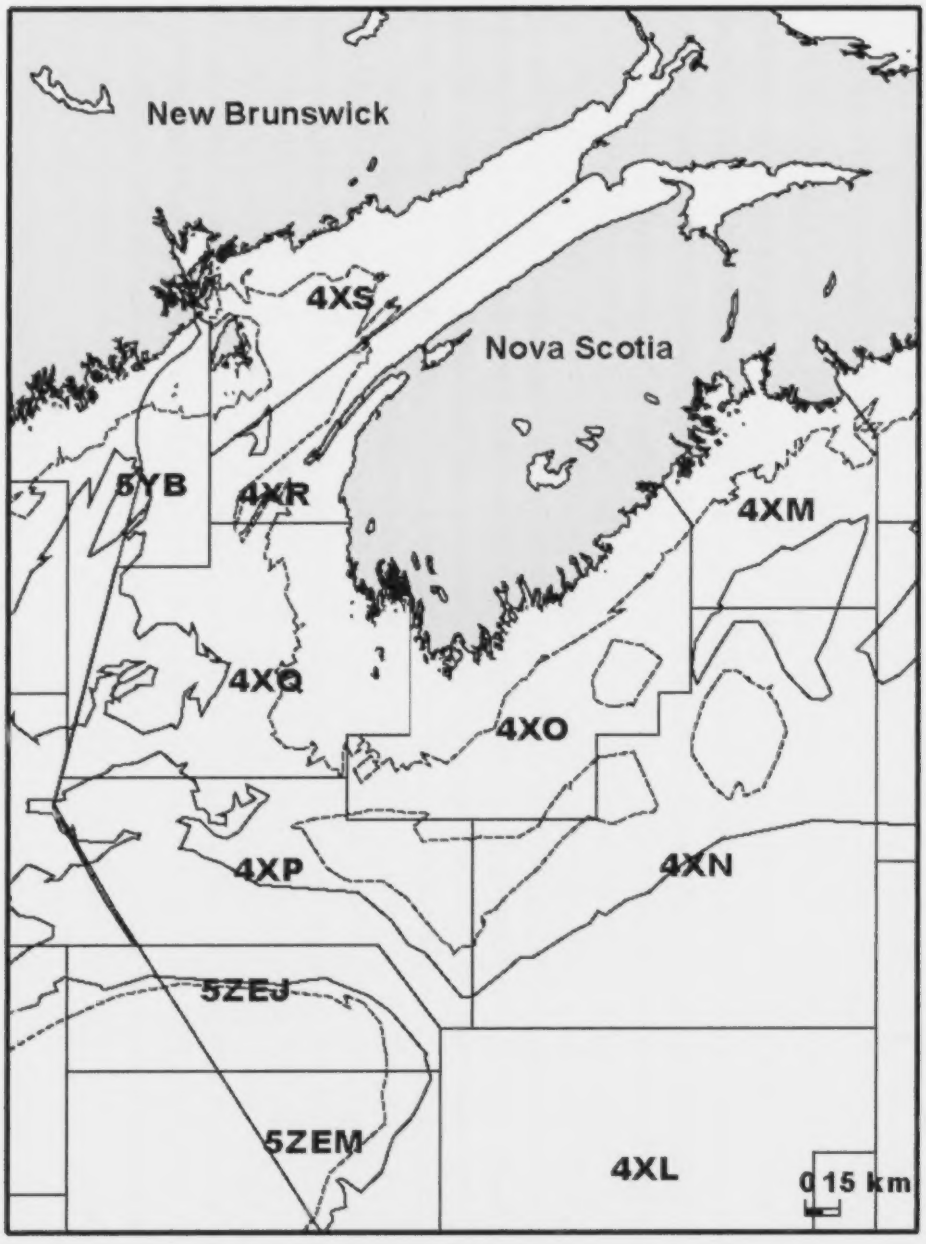


Figure 1. Map of NAFO statistical fishing areas in the Bay of Fundy and western Scotian Shelf. Haddock landed from statistical areas 5ZEM and 5ZEJ are not included in the 4X5Y haddock stock assessment.

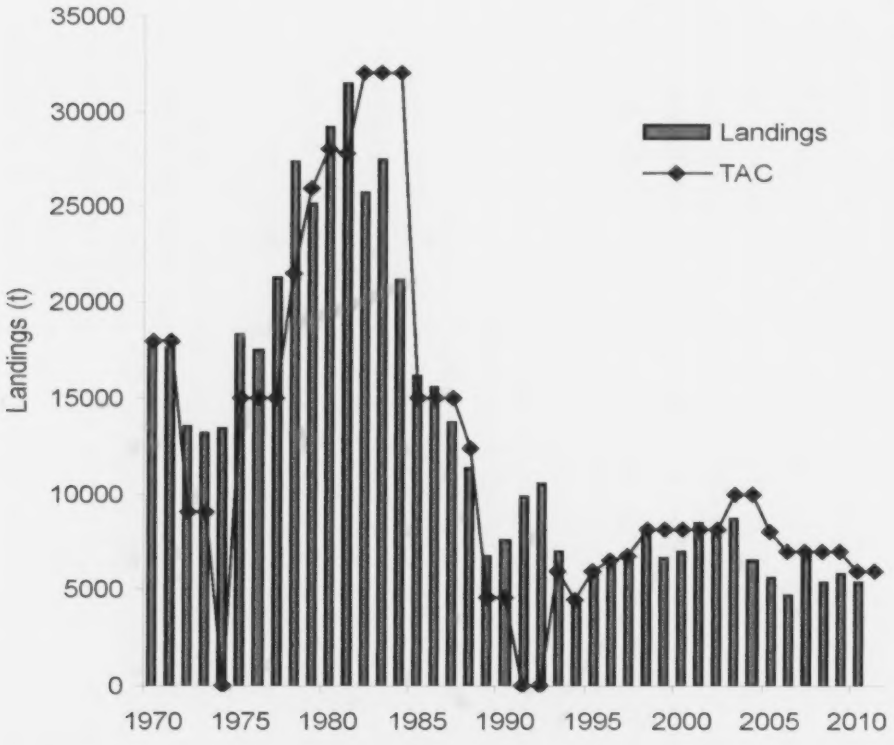


Figure 2. Commercial landings and TAC (t) of 4X5Y haddock from 1970-2010.

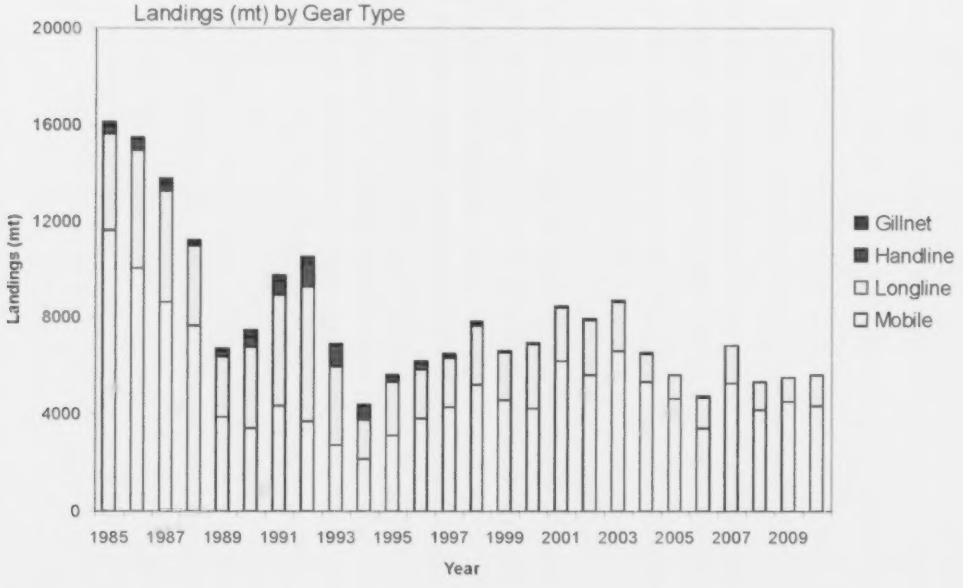


Figure 3. Landings (t) for 4X5Y haddock catches by gear type (gillnet, handline, longline and mobile) from 1985-2010.

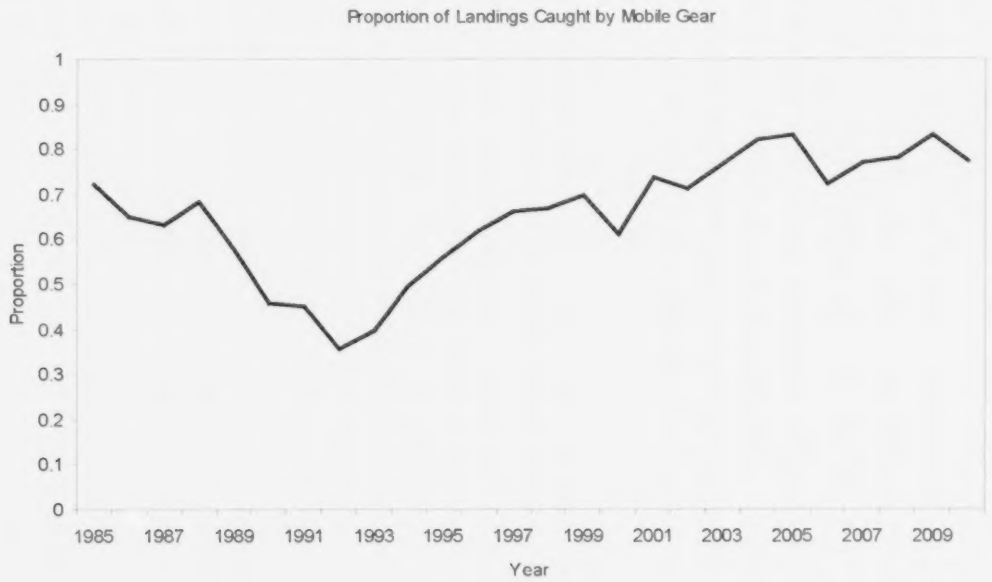


Figure 4. Proportion (%) of 4X5Y haddock landed by mobile gear from 1985-2010.

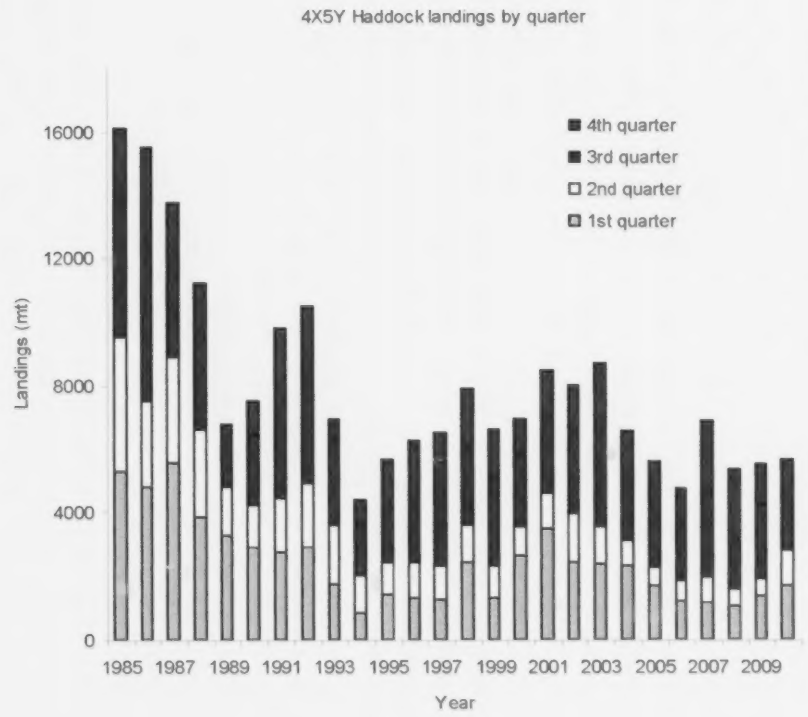


Figure 5. Landings (t) of 4X5Y haddock catches by quarter (1st quarter, January-March; 2nd quarter, April-June; 3rd quarter, July-September; 4th quarter, October-December), from 1985-2010.

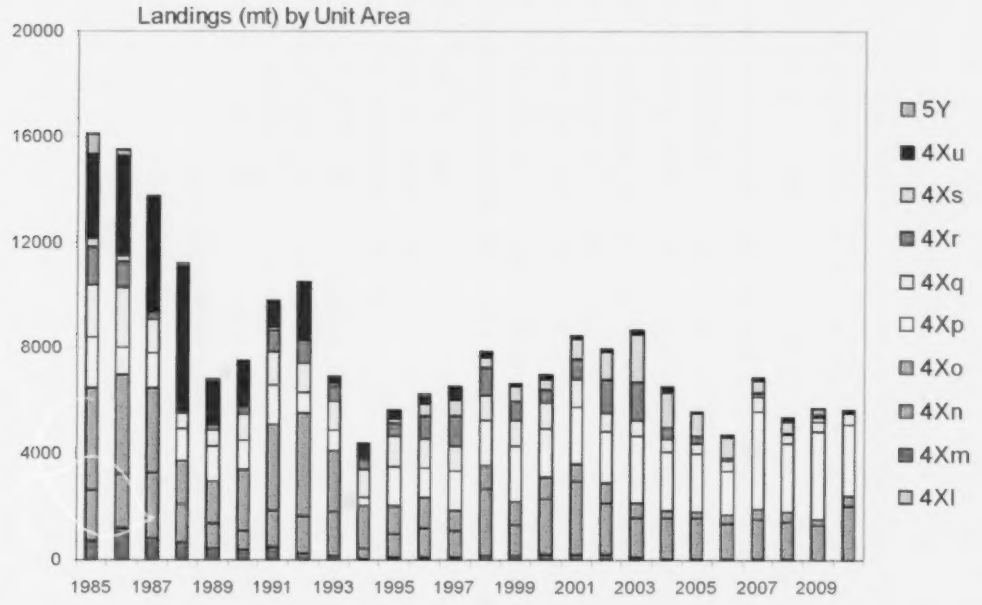


Figure 6. Distribution of 4X5Y haddock landings (t) by NAFO unit area, from 1985-2010.

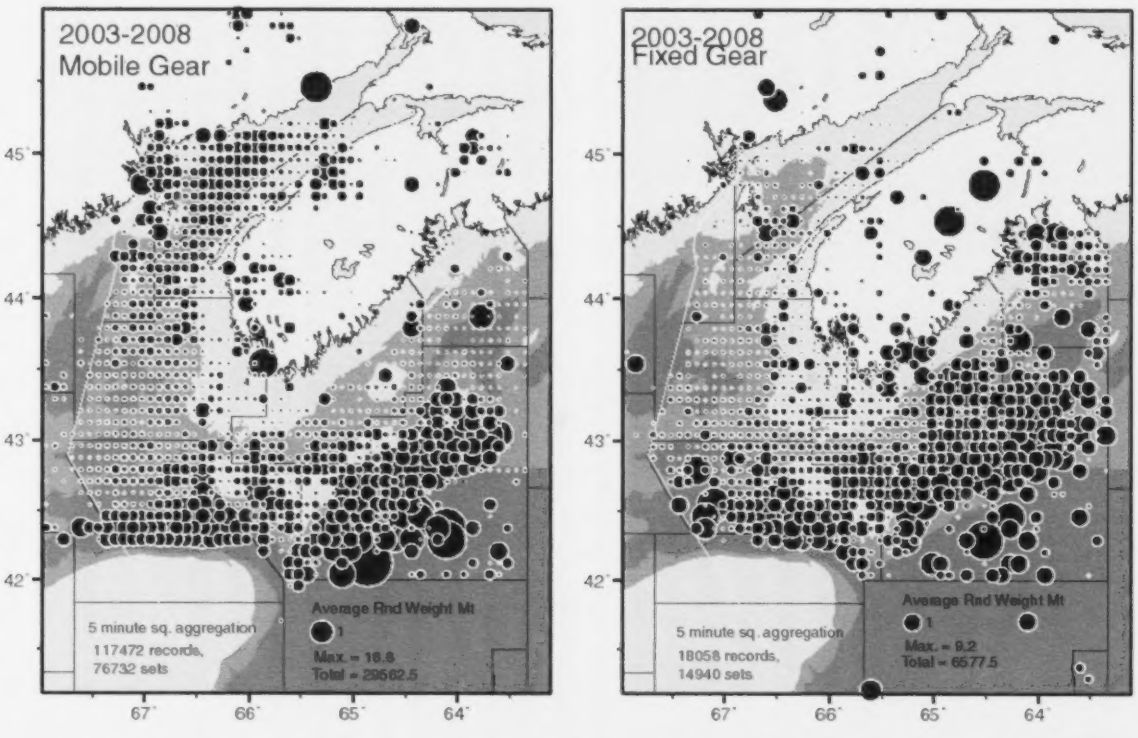


Figure 7. Distribution of 4X5Y haddock landings (t) by mobile and fixed gears averaged over 2003-2008.

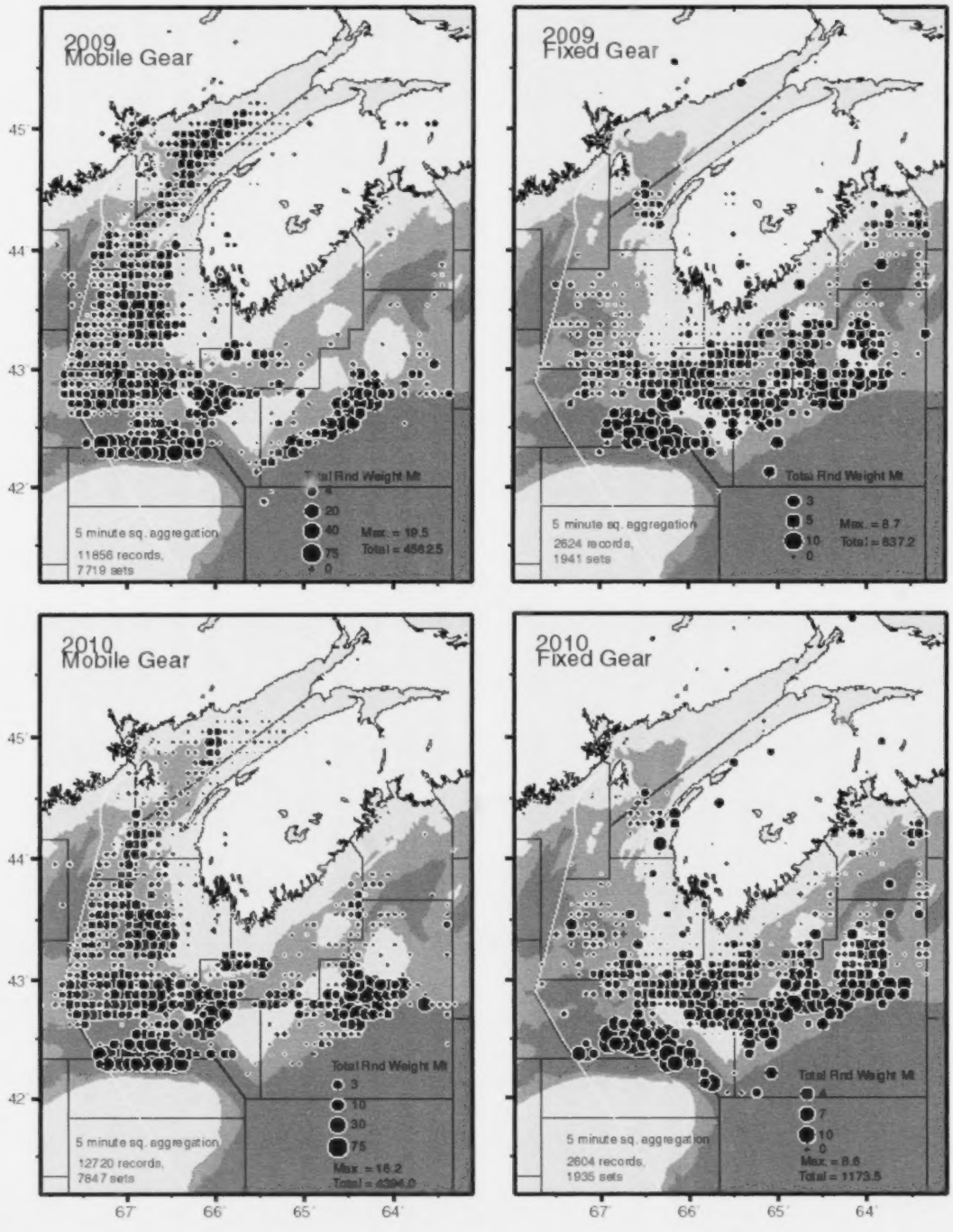


Figure 8. Distribution of total haddock landings (t) in NAFO Division 4X5Y by mobile and fixed gears in 2009 and 2010.

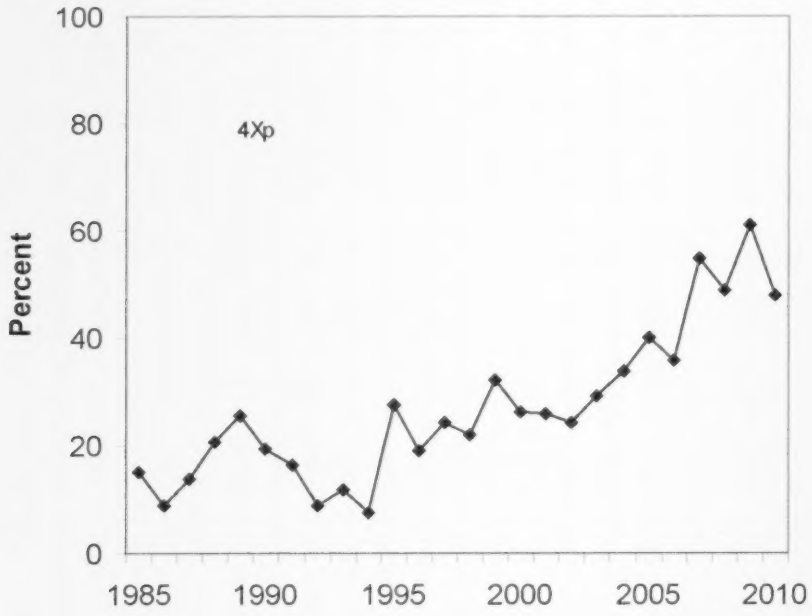


Figure 9. Percentage of total 4X5Y haddock landed (t) in NAFO Unit Area 4Xp from 1985-2010.

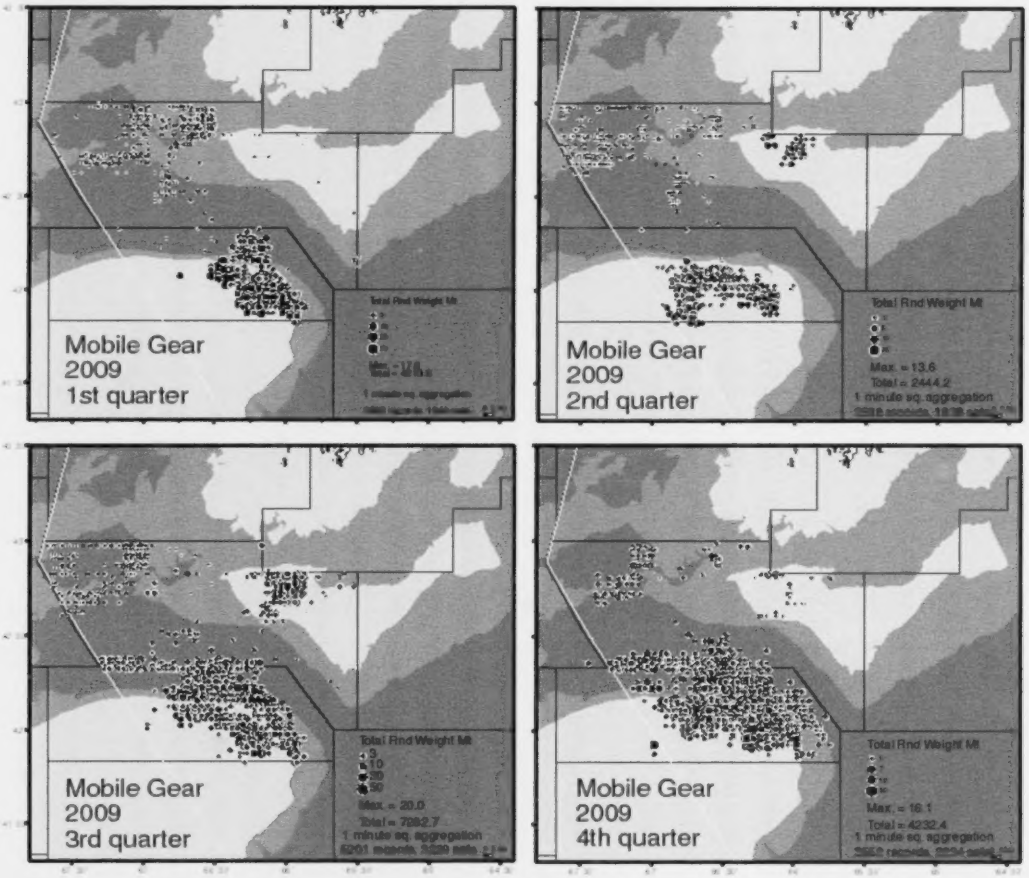


Figure 10. Distribution of total landings (t) of 4X5Y haddock caught by mobile gear in 2009 by quarter in NAFO Unit Areas 4Xp and 5Zej.

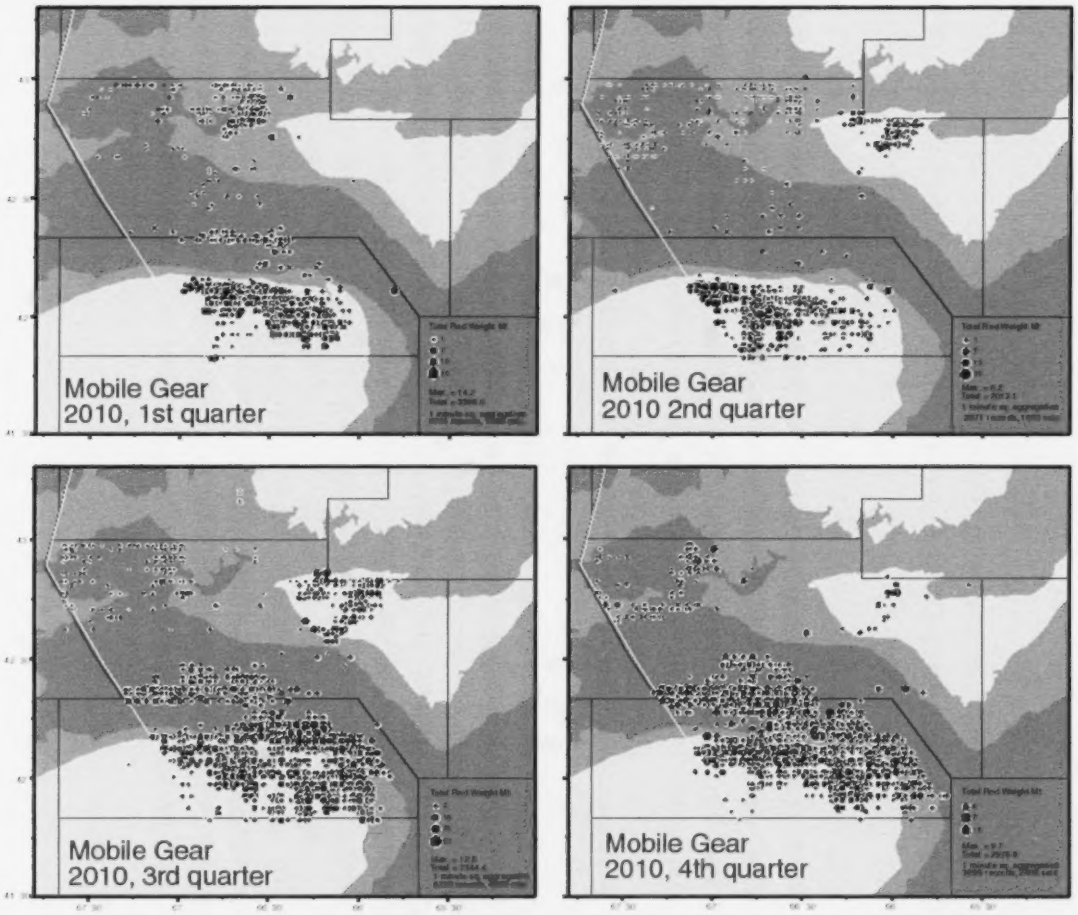


Figure 11. Distribution of total landings (t) of 4X5Y haddock caught by mobile gear in 2010 by quarter in NAFO Unit Areas 4Xp and 5Zej.

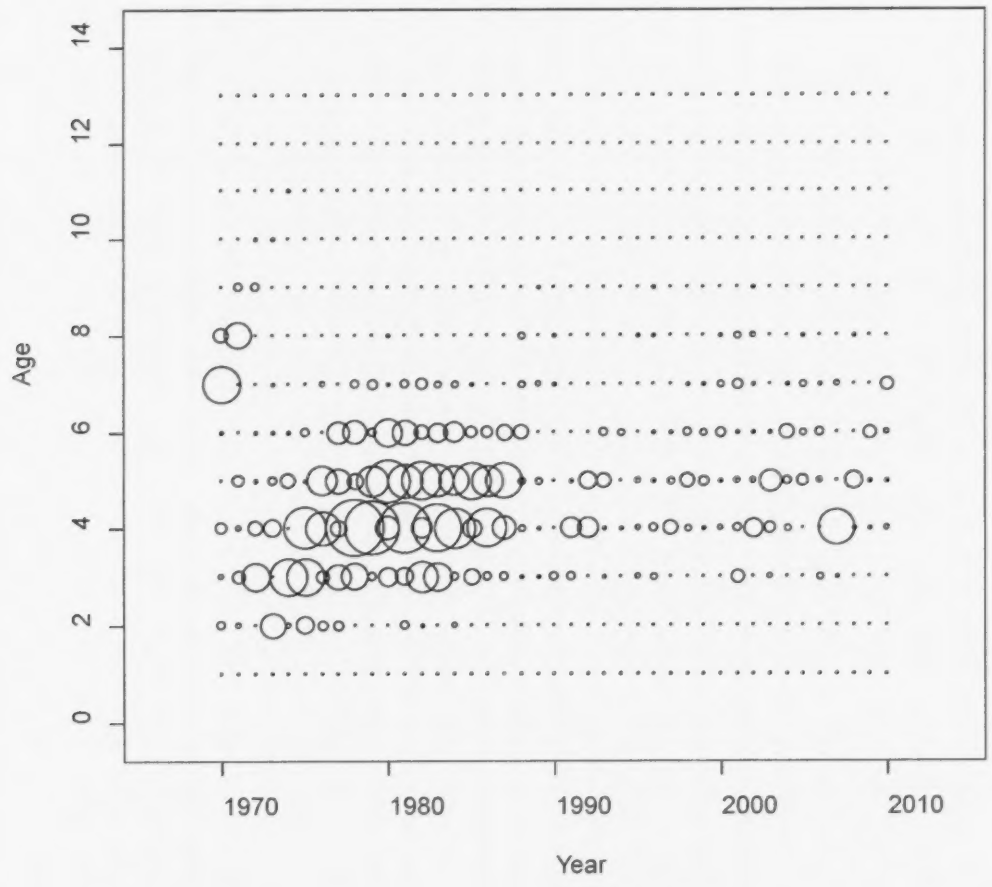


Figure 12. Trends in commercial catch at age of 4X5Y haddock from 1970-2010. Diameter of circle is proportional to the size of the year class relative to the entire time series.

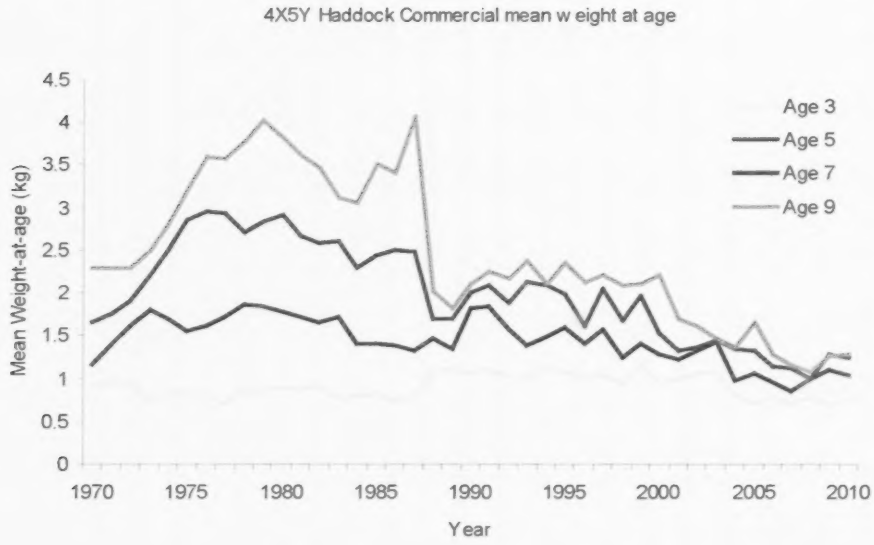


Figure 13. Commercial mean weight at age (kg) for 4X5Y haddock (ages 3, 5, 7 and 9) from 1970-2010.

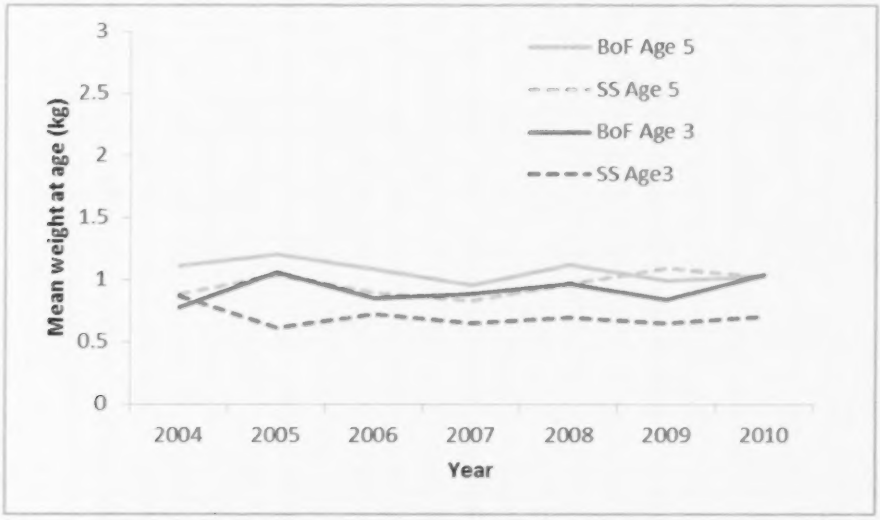


Figure 14a. Trends in commercial mean weight at age (kg) for 4X5Y haddock ages 3 and 5 in the Scotian Shelf (SS, Unit Area 4Xmnop) and Bay of Fundy (BoF, Unit Area 4Xqrs5Y) from 2004-2010.

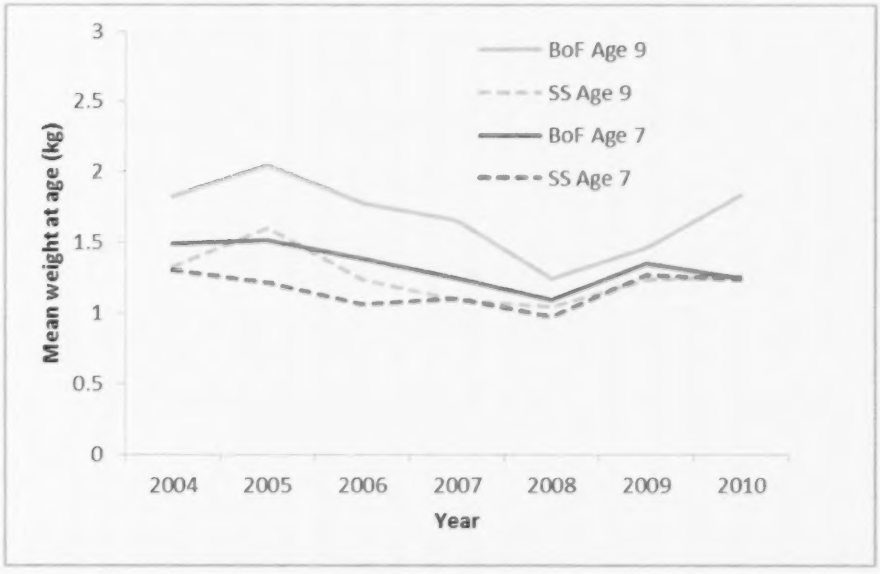


Figure 14b. Trends in commercial mean weight at age (kg) for 4X5Y haddock ages 7 and 9 in the Scotian Shelf (SS, Unit Area 4mnop) and the Bay of Fundy (BoF, Unit Area 4Xqrs5Y) from 2004-2010.

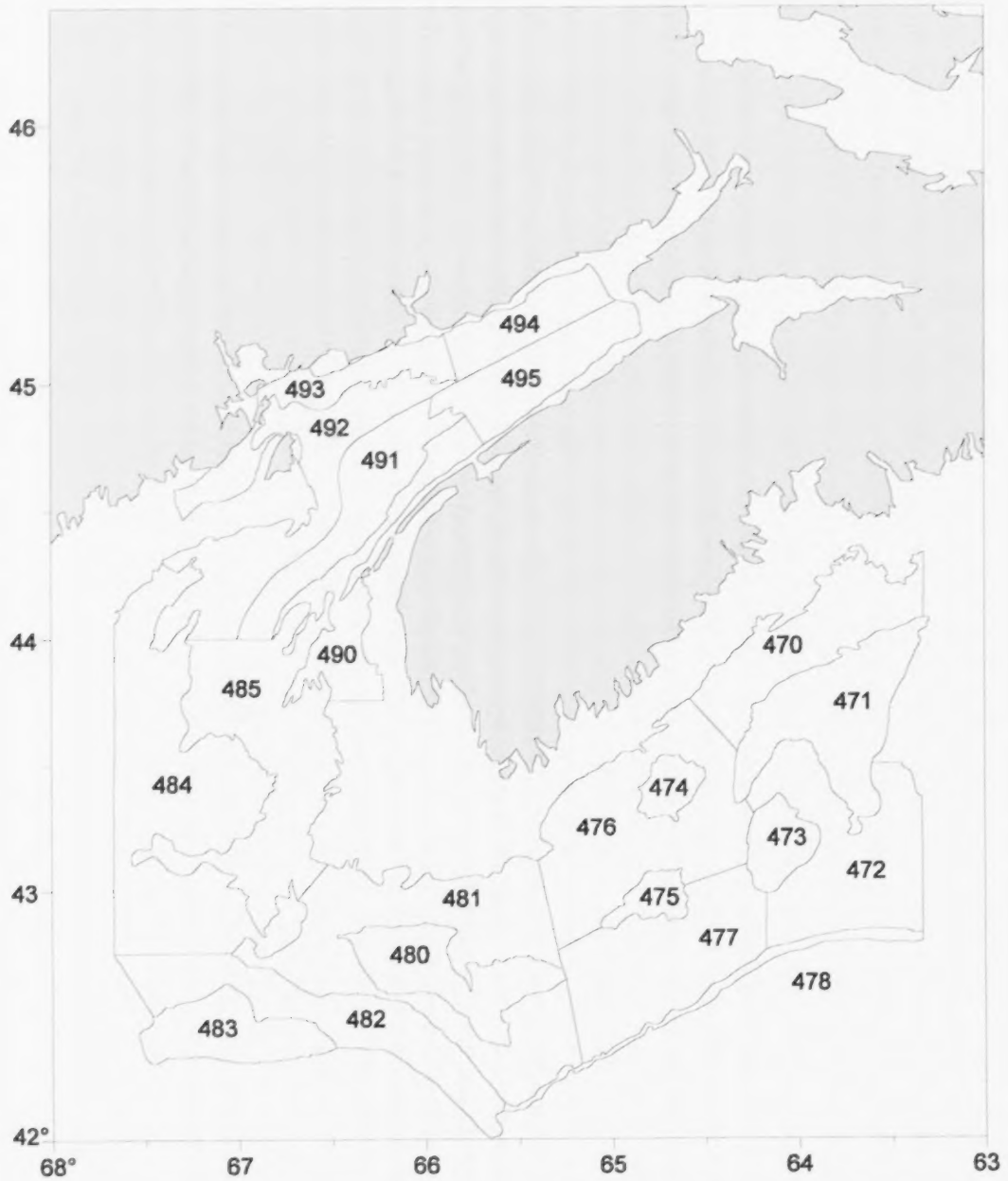


Figure 15. Location of strata used in the summer RV survey. Strata 470-481 represent the Scotian Shelf and strata 482-495 represent the Bay of Fundy.

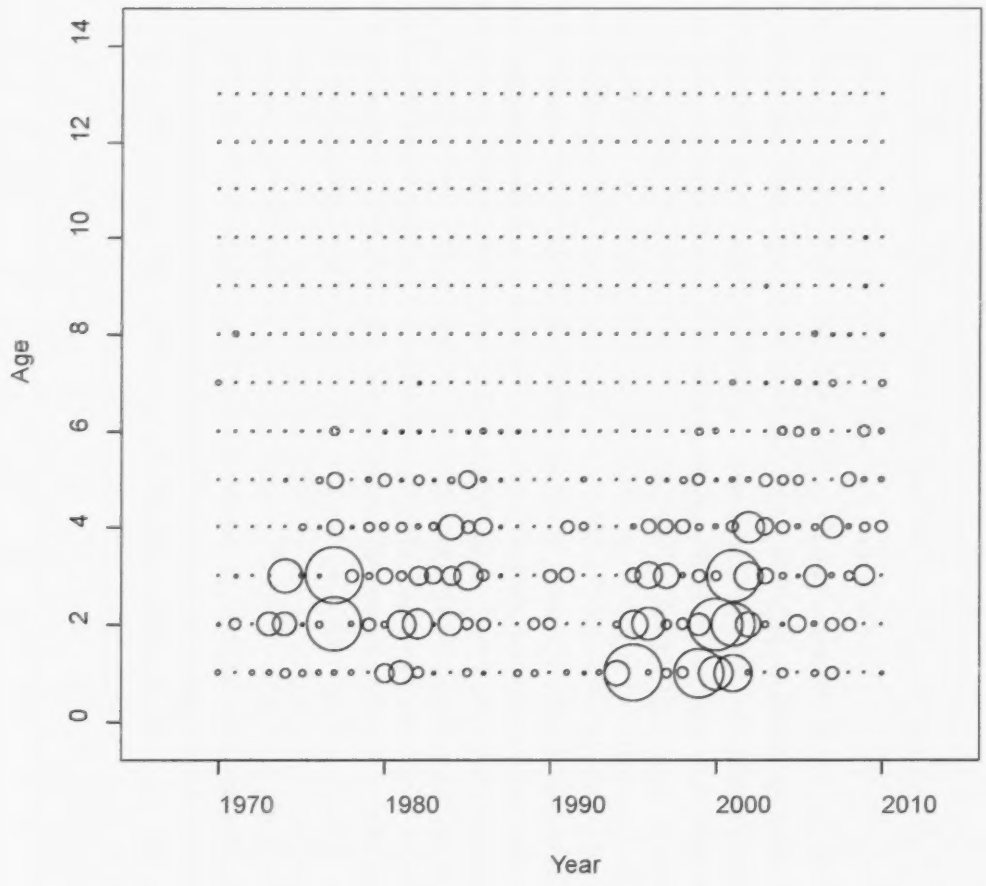


Figure 16. Trends in numbers at age of 4X5Y haddock in the summer RV survey from 1970-2010. Size of circle is proportional to the size of a year class relative to the entire time series.

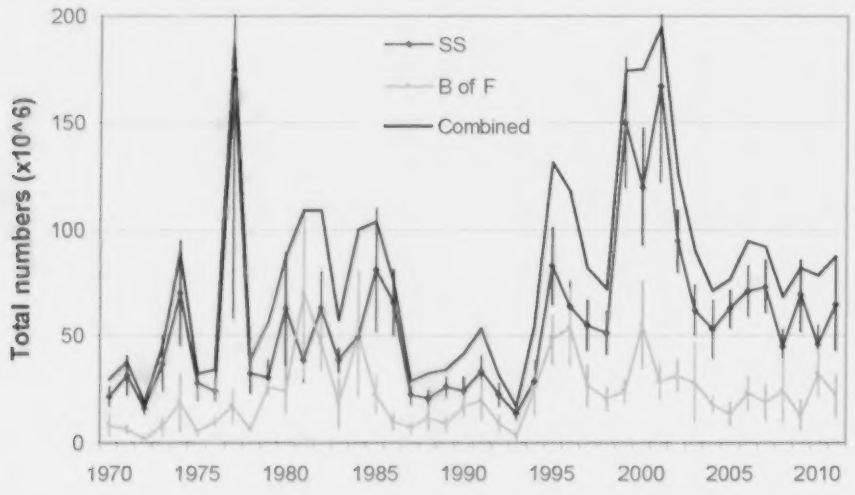


Figure 17. Summer RV survey stratified total numbers (x10^6) by area for 4X5Y haddock (SS – Scotian Shelf; B of F – Bay of Fundy) from 1970-2010.

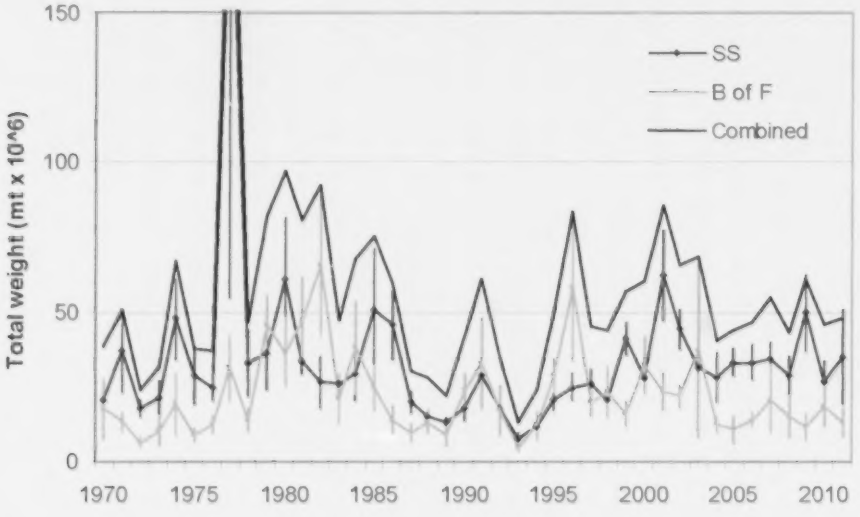


Figure 18. Summer RV survey total weight (mt x 10^6) by area for 4X5Y haddock (SS - Scotian Shelf; B of F - Bay of Fundy) from 1970-2010.

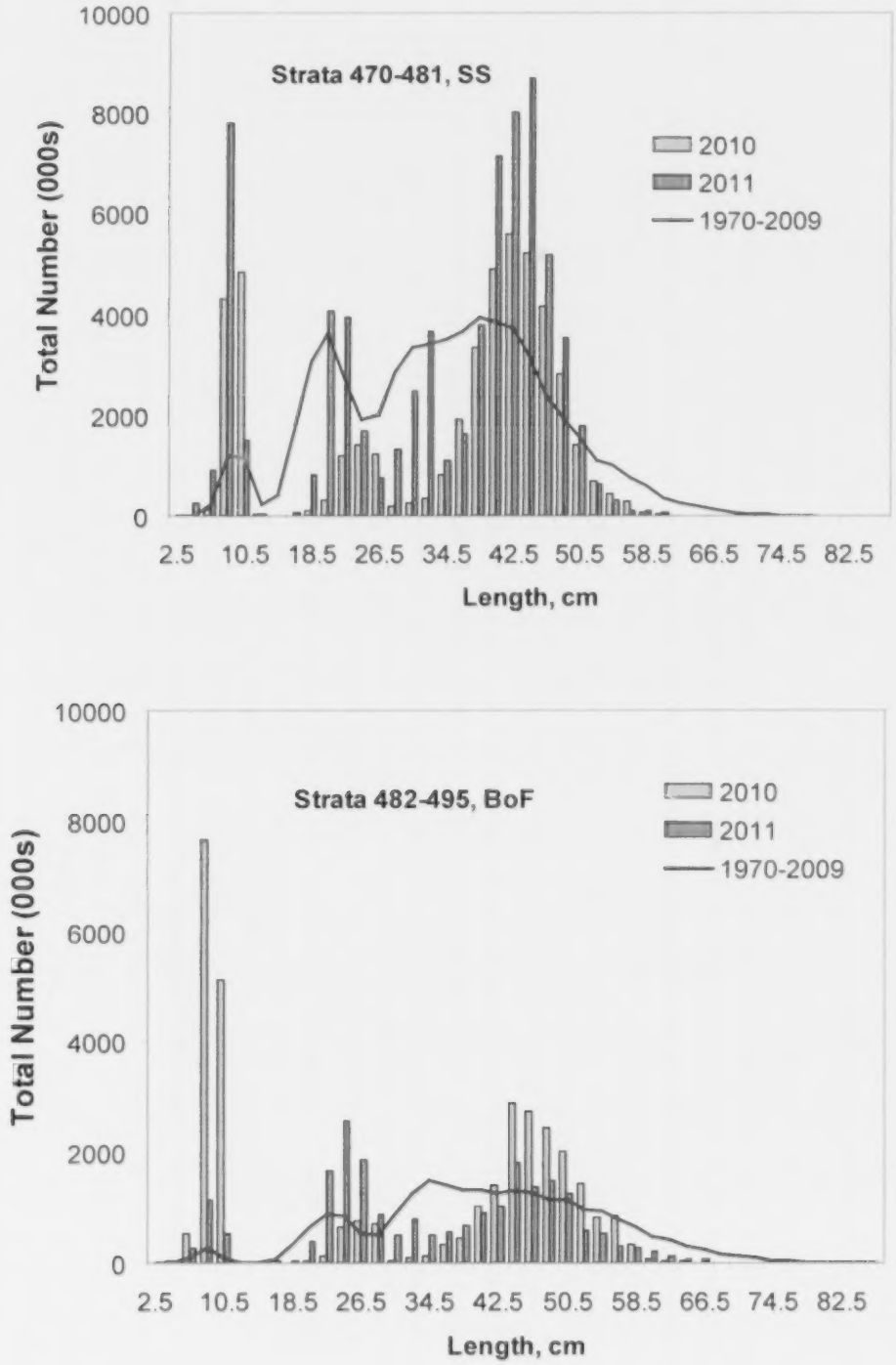


Figure 19. Length (cm) frequency plots of haddock from the summer RV survey of the Scotian Shelf (top: strata 470-481) and the Bay of Fundy (bottom: 482-495), for years 1970-2009 (blue line), 2010 (green bar) and 2011 (red bar).

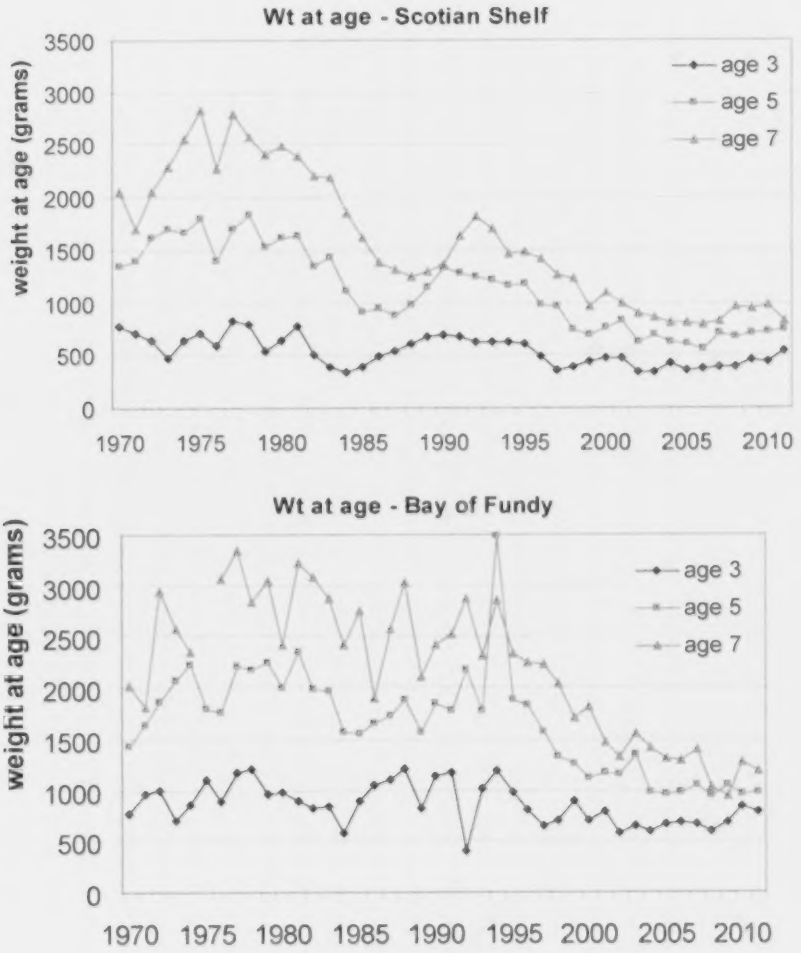


Figure 20. Mean weight at age (g) for Scotian shelf (top) and Bay of Fundy (bottom) 4X5Y haddock in the summer RV survey from 1970-2010.

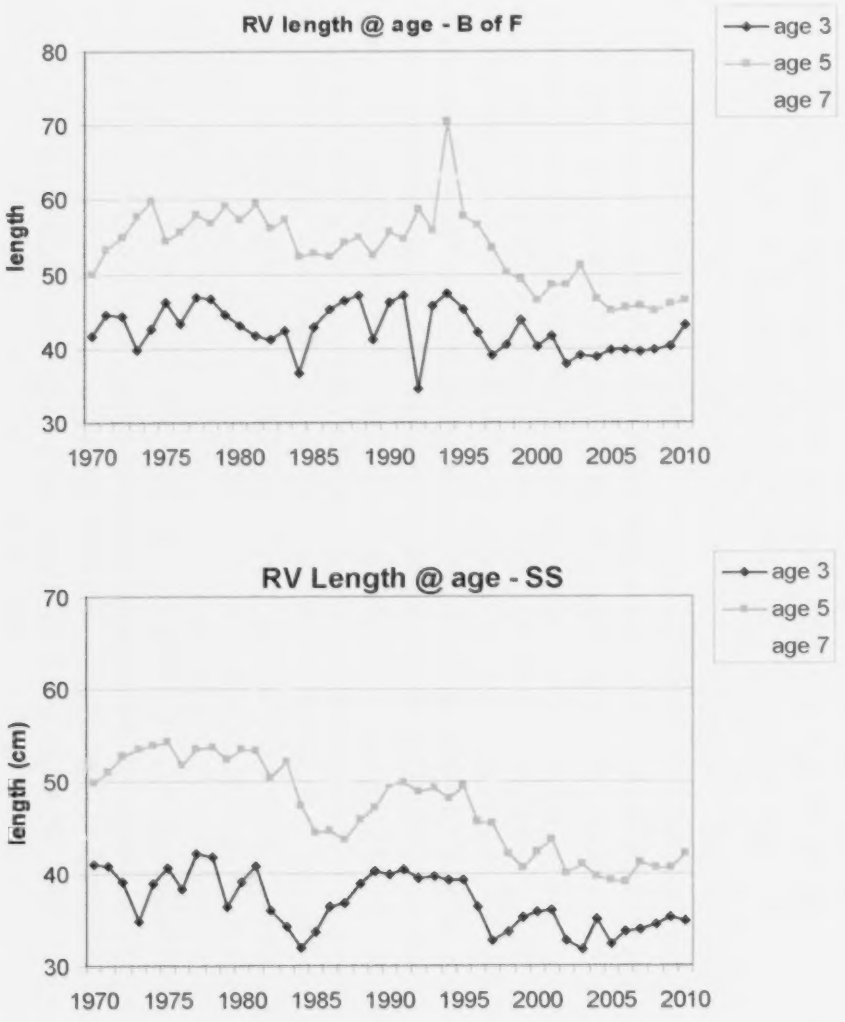


Figure 21. Mean length at age (cm) of 4X5Y haddock (ages 3, 5 and 7) in the summer RV survey (top: Bay of Fundy; bottom: Scotian Shelf) from 1970-2010.

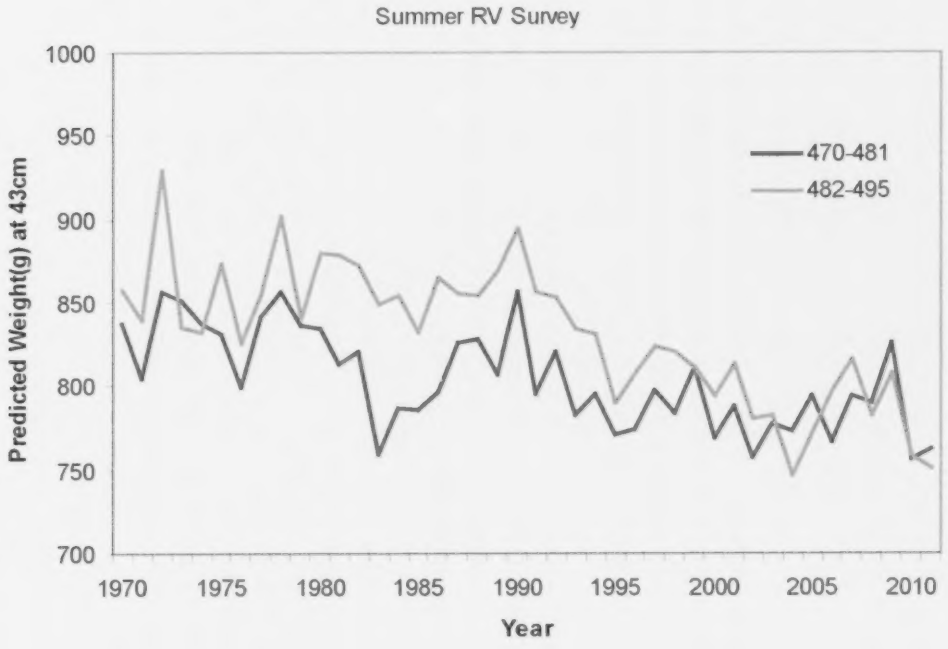


Figure 22. Condition index estimated as the predicted weight (g) at 43 cm of 4X5Y haddock in the summer RV survey: blue line - strata 470-481 (Scotian Shelf); red line - strata 482-495 (Bay of Fundy), from 1970-2010.

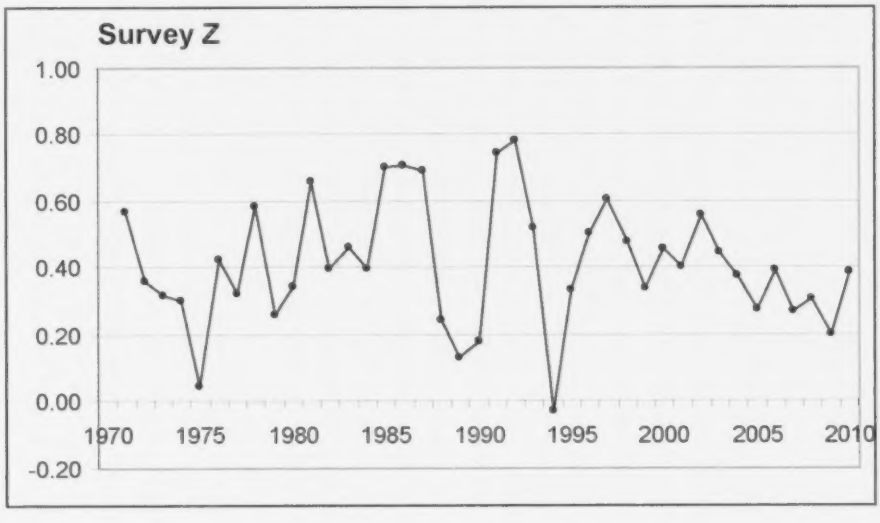


Figure 23. Total mortality (Z) estimated for ages 5-9 of 4X5Y haddock in the summer RV survey with a smoothed three year running average from 1970-2010.

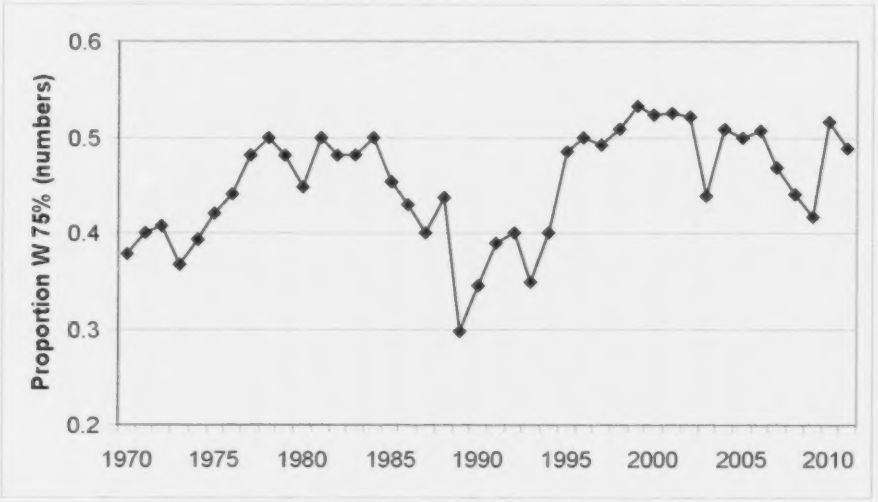


Figure 24. Spatial distribution index of 4X5Y haddock estimated as the proportion of the historical stock area containing 75% of the population numbers from 1970-2010.

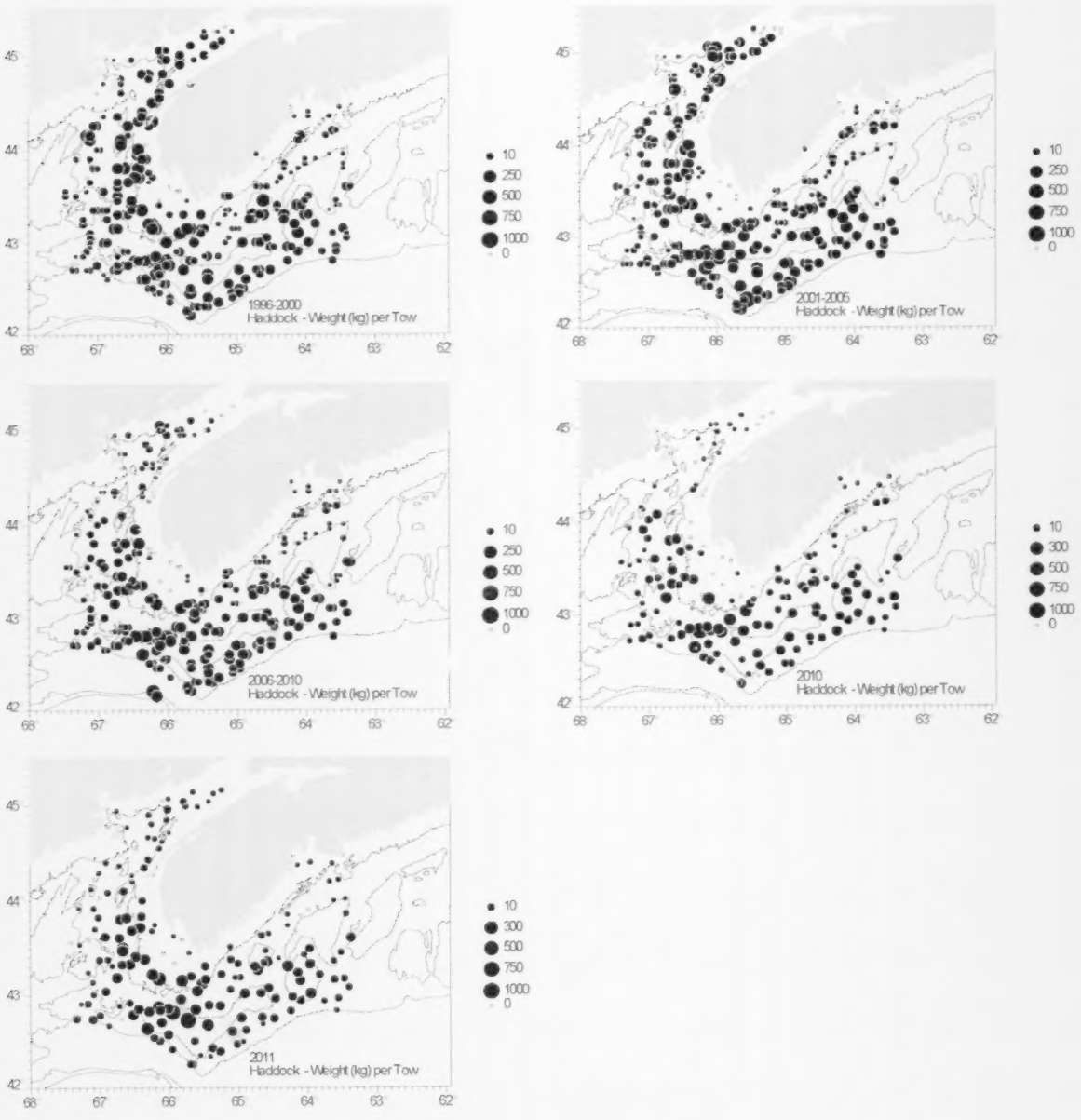


Figure 25. Distribution of 4X5Y haddock (kg per tow) in the ITQ survey from 1996-2010.

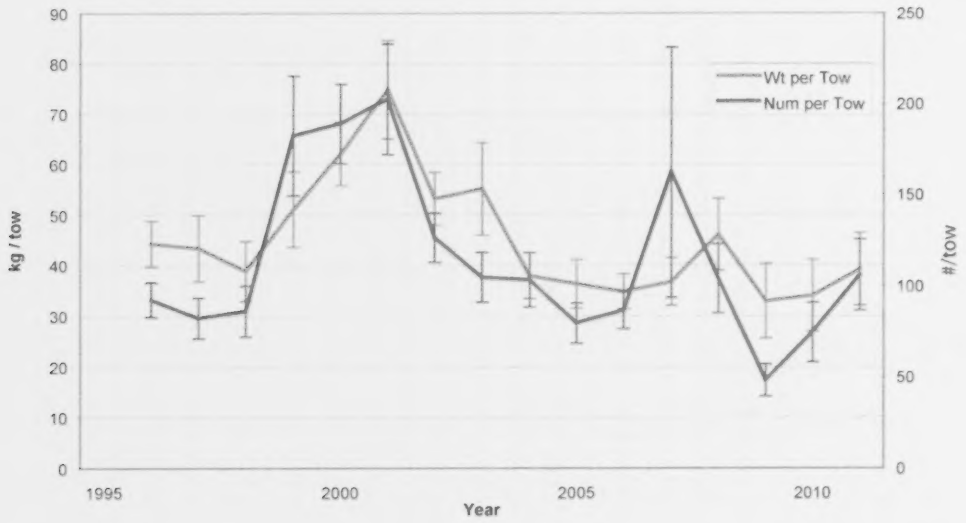


Figure 26. Trends in abundance (numbers/tow) and biomass (kg/tow) of 4X5Y haddock in the ITQ survey from 1996-2011.

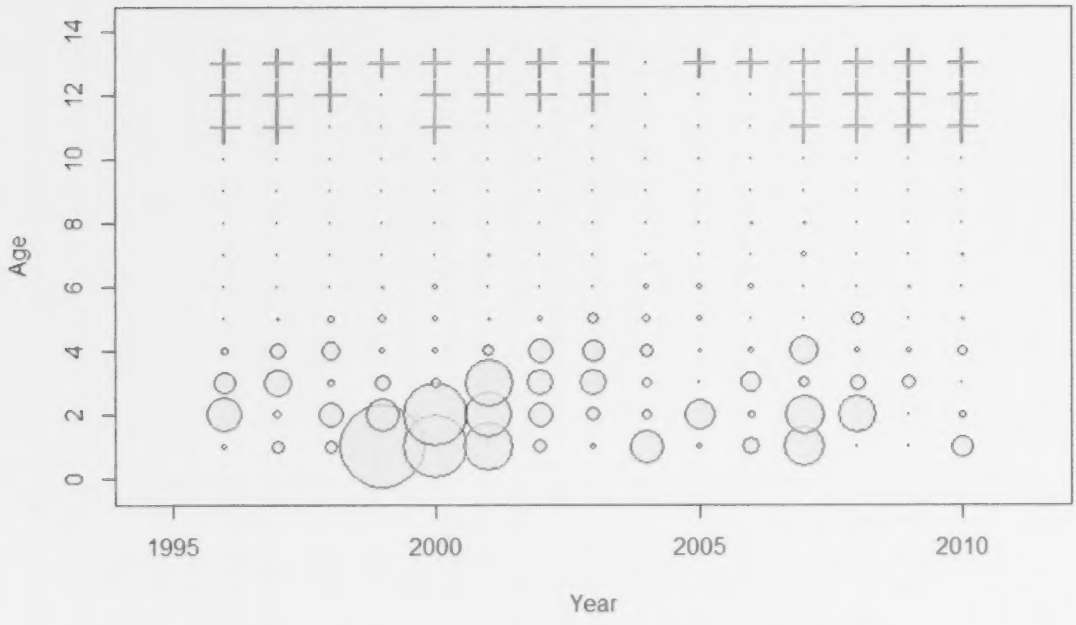


Figure 27. Trends in numbers at age of 4X5Y haddock in the ITQ survey from 1996-2010. Size of circle (green) is proportional to the size of a year class relative to the entire time series. The plus sign (+; red) indicate no observations for that age.

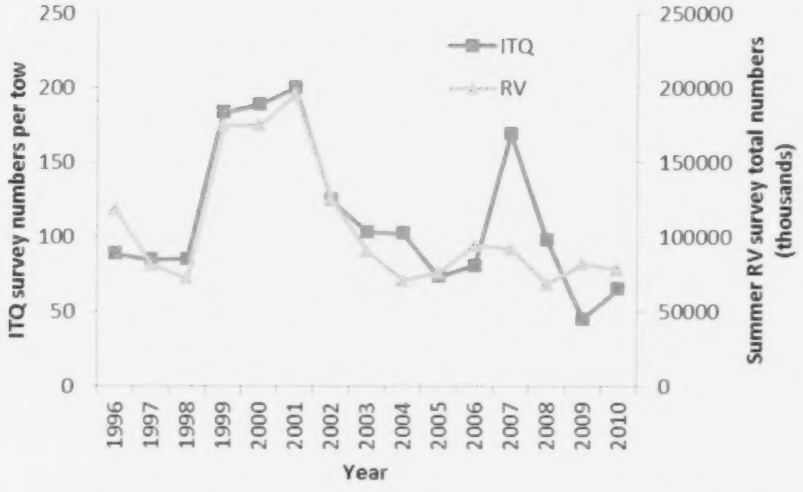


Figure 28. Comparison of trends in abundance of 4X5Y haddock caught in the summer RV (total numbers) and ITQ surveys (numbers per tow) from 1996-2010).

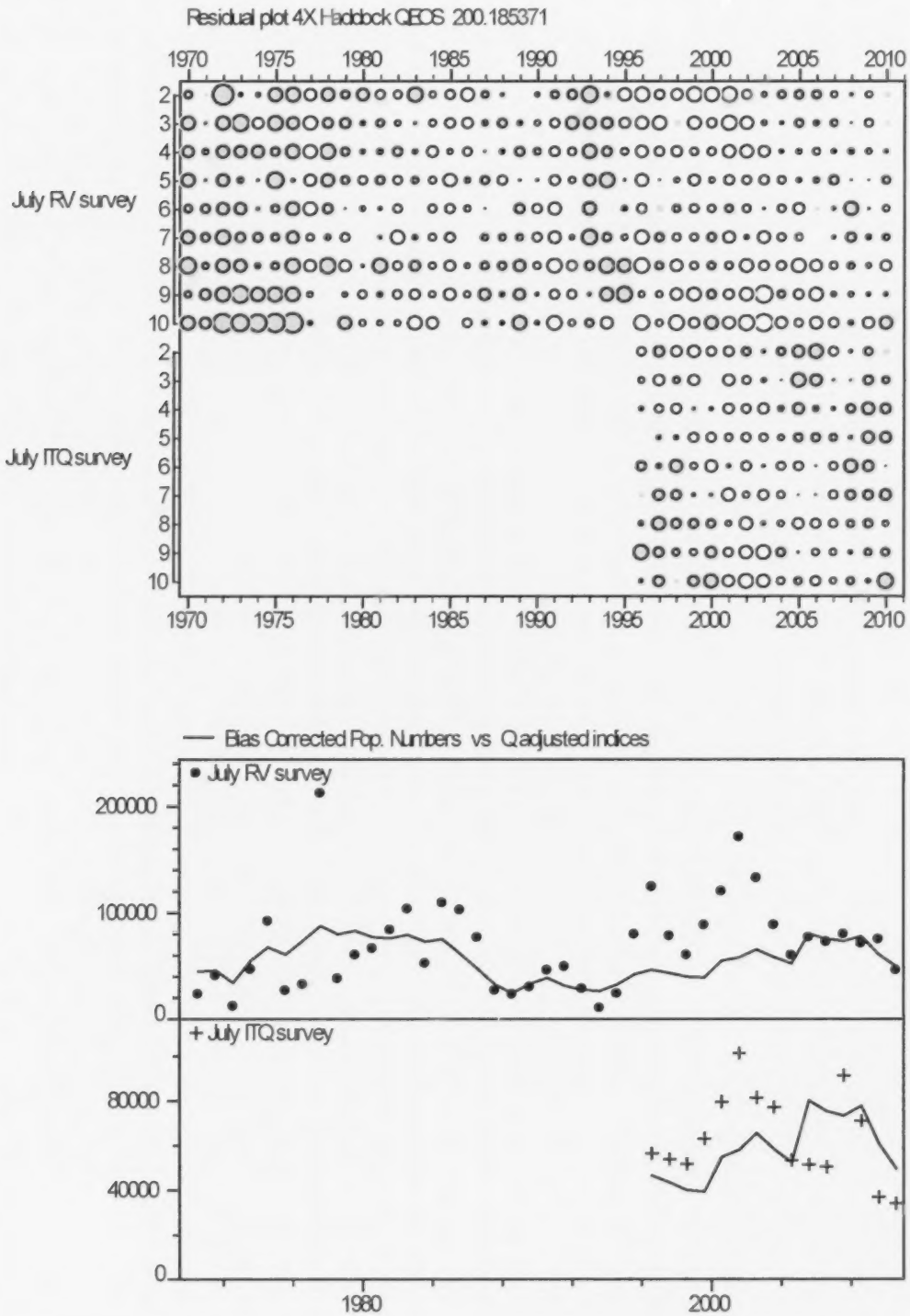


Figure 29. Residuals at age (upper panel; ages 2-10) and population numbers (bottom panel; thousands) estimated from the population model and the q-adjusted summer RV and ITQ surveys for 1970-2010.

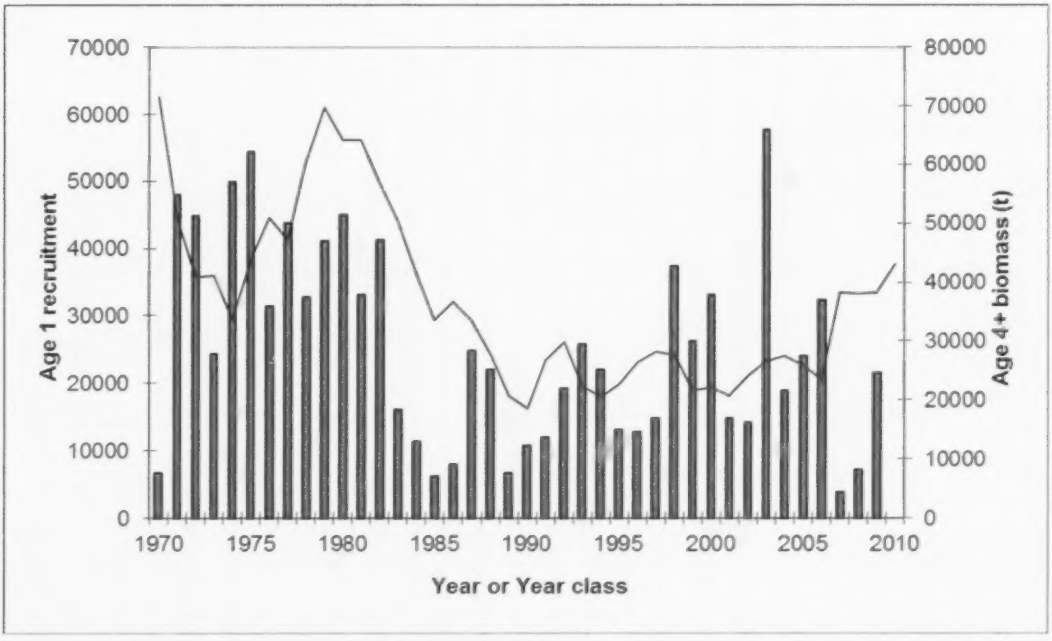


Figure 30a. Spawning stock biomass (ages 4+ in tons) (line) and numbers of age 1 (bars) predicted for 4X5Y haddock from the population model from 1970-2010.

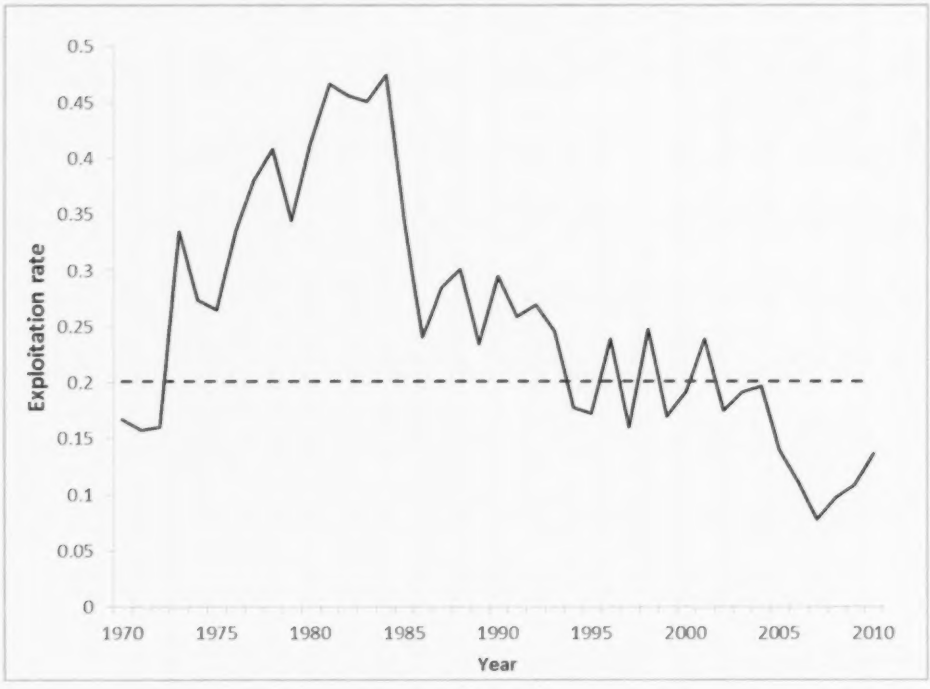


Figure 30b. Averaged exploitation rate for ages 5-7 of 4X5Y haddock from 1970 to 2010 from the population model using 13 age groups. $F_{0.1}$ indicated by dashed line.

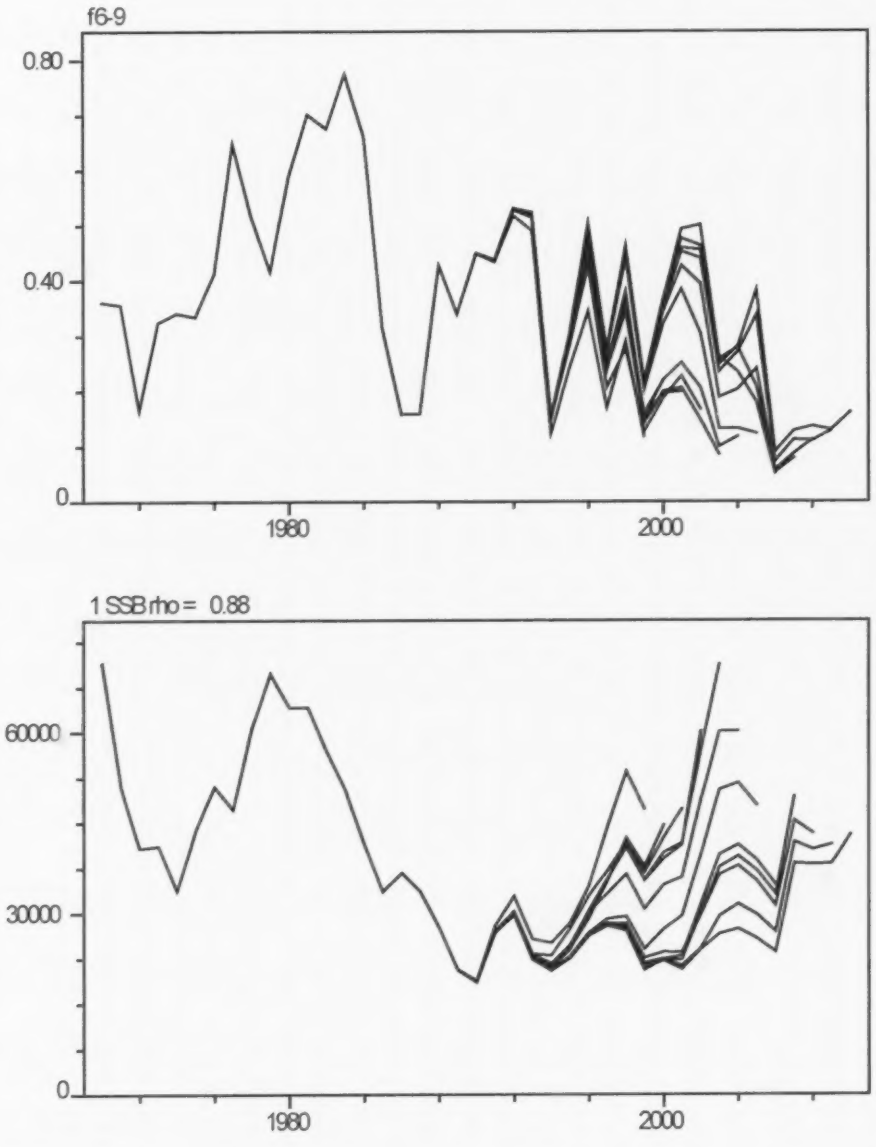


Figure 31. Retrospective patterns for the population model. Top panel shows trends in fishing mortality F for ages 6-9. Bottom panel shows trends in SSB.

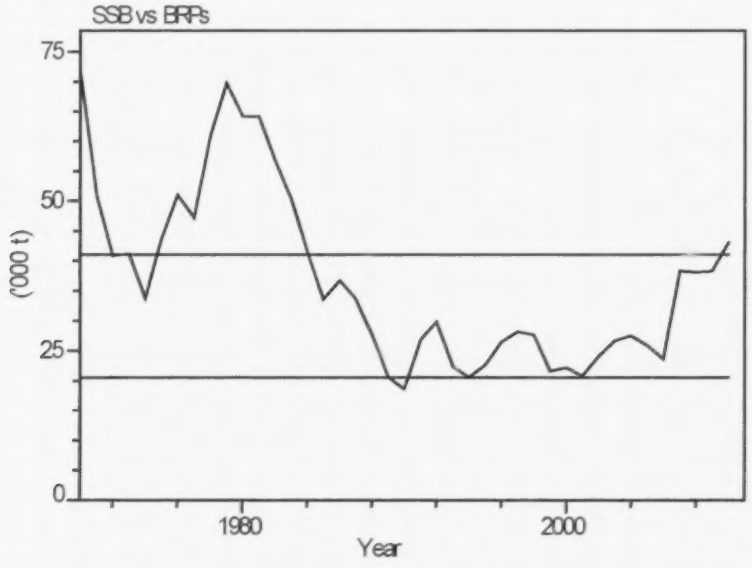


Figure 32. History of SSB (MSY) for 4X5Y haddock with biological reference levels shown. The upper line is 80% of the SSB at MSY and proposed as the USR. The lower line is at 40% of the SSB at MSY and proposed as the LRP.

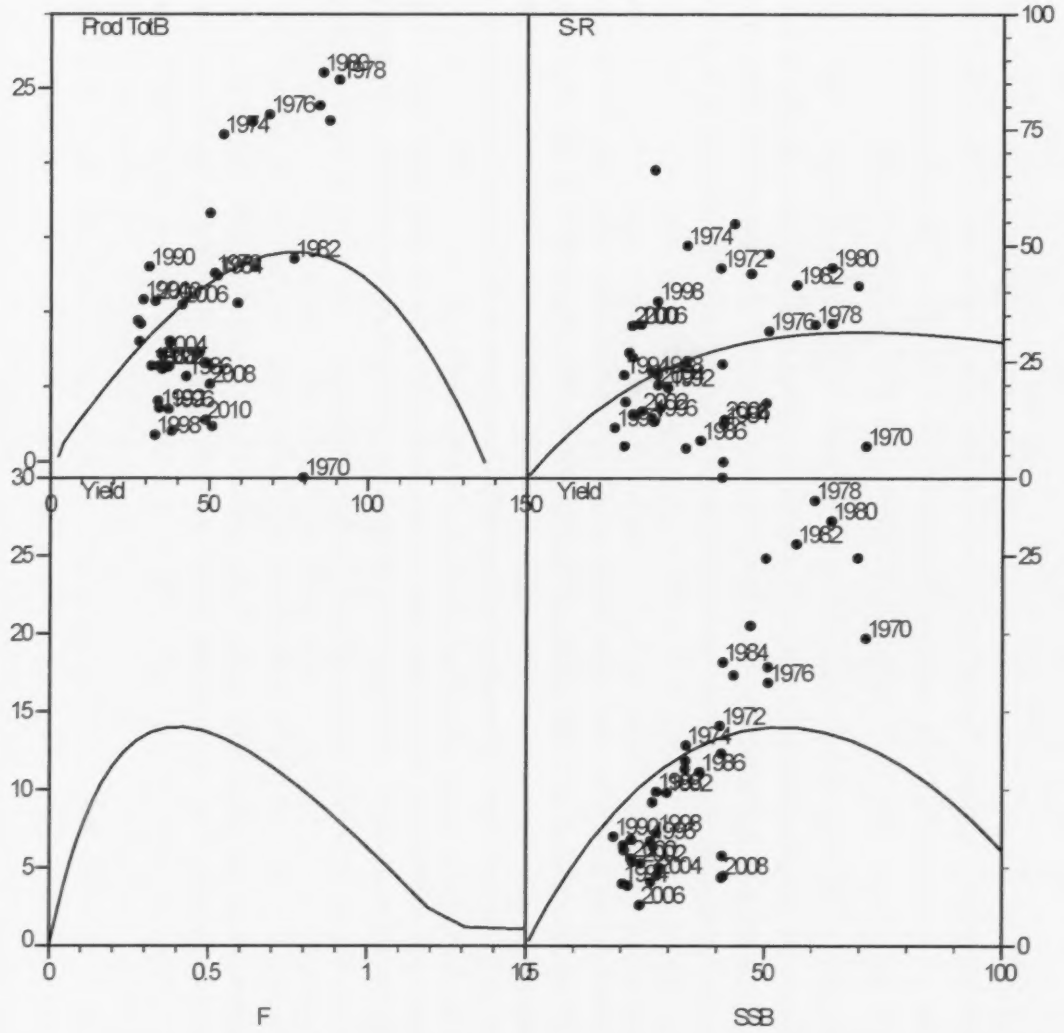


Figure 33. Sissenwine-Shepherd production model for 4X5Y haddock. The upper left plot is production as a function of total biomass with the equilibrium line shown. The peak of this line at 14,700 t is MSY. The upper right plot is a stock-recruit relationship showing a Ricker curve. The lower left plot is yield (1,000 t) as a function of fishing mortality F, and it shows F_{MSY} at about 0.43. The lower right plot shows yield as a function of SSB.

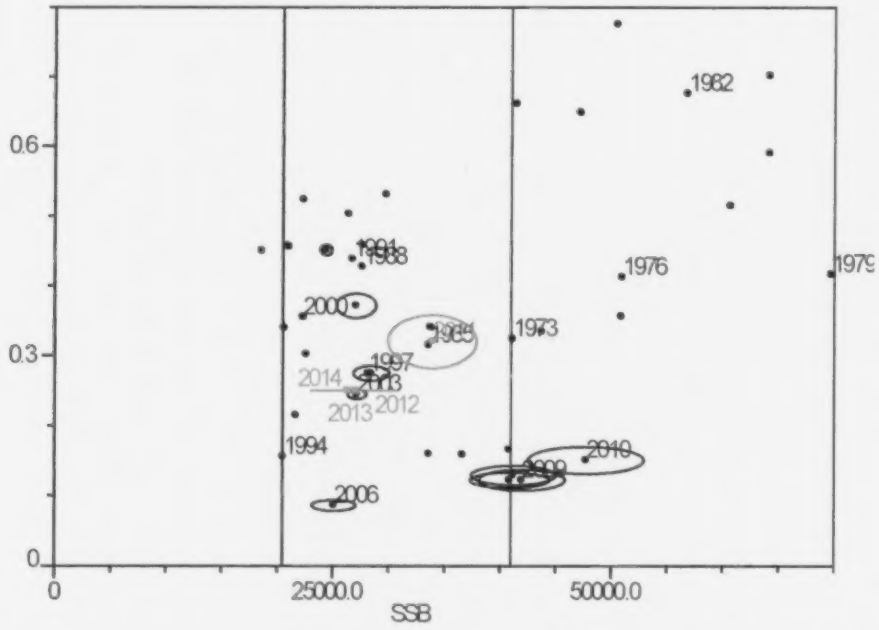


Figure 34. Stock status of 4X5Y haddock in relation to reference points. The red dots are the projected values, while the ellipses are 1 standard deviation. Vertical lines are references at 40% (left side) and 80% (right side) of SSB (t) at MSY.

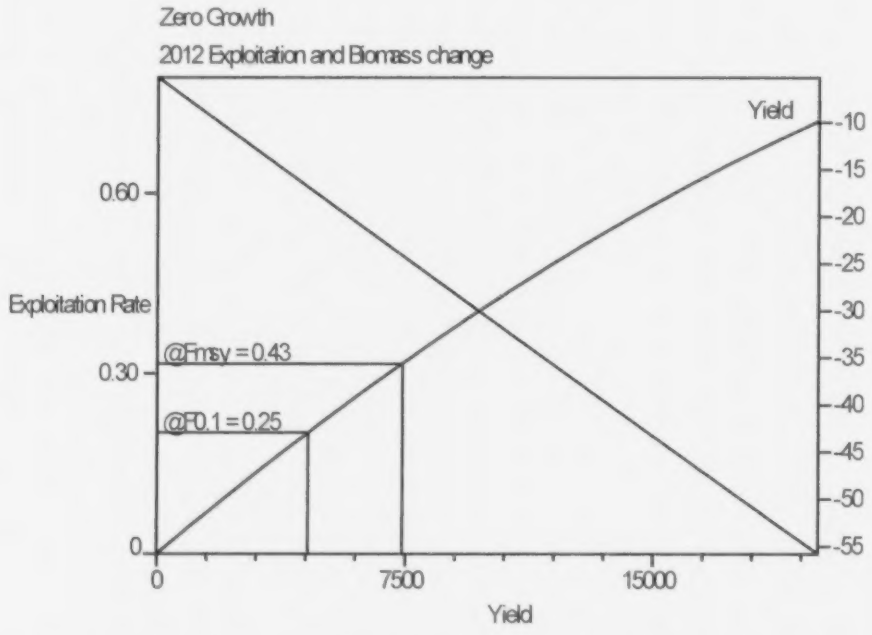


Figure 35. Armstrong plot showing trajectories of exploitation rate (left vertical axis) and change in spawning stock biomass (right vertical axis) at various levels of yield in 2012 with consequences of no fishing, fishing at $F_{0.1}$ and fishing at F_{msy}.

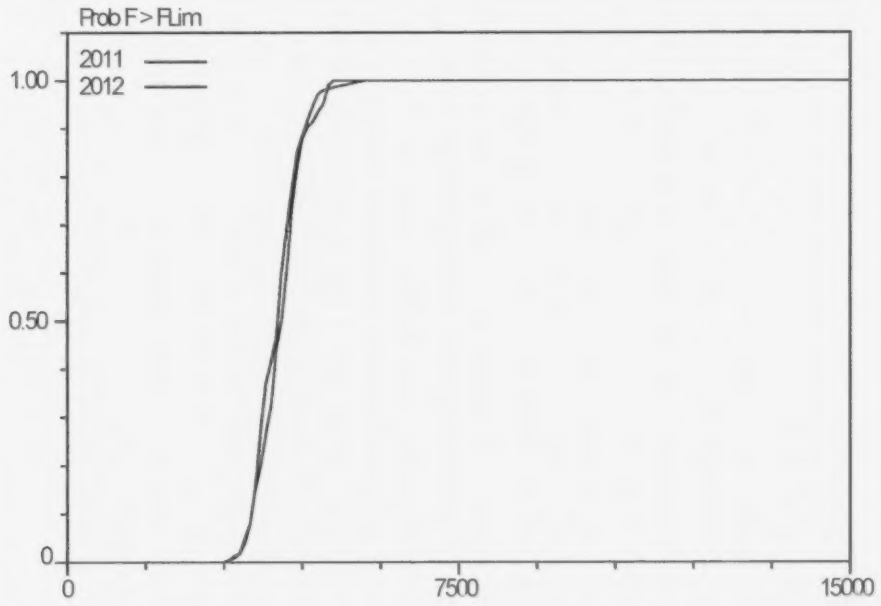


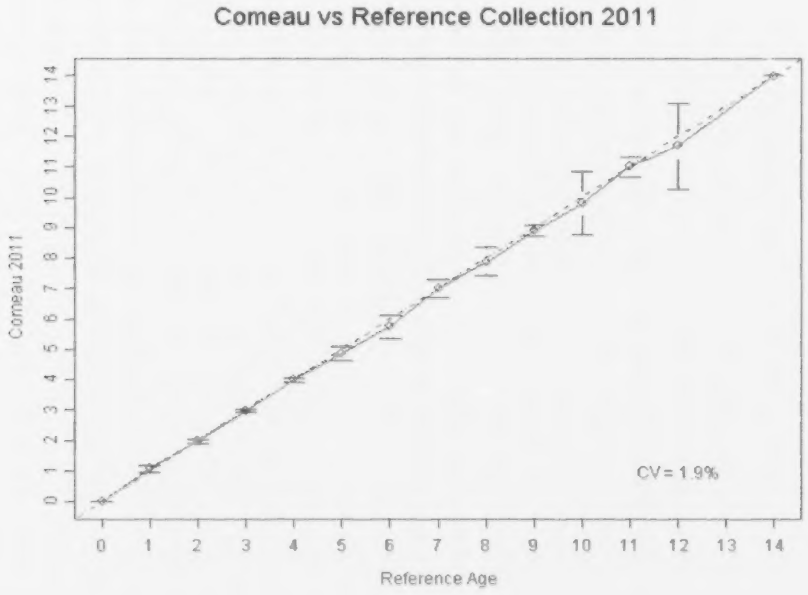
Figure 36: Probability that $F_{0.1}$ will be exceeded at levels of yield in 2011 and 2012.

APPENDIX

RESULTS OF TESTING AGAINST REFERENCE COLLECTION

Appendix Table 1. Ages assigned by primary 4X5Y haddock ager for reference collection ages.

	Primary Ager														
Reference Age	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**14**	**Total**
0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	3
1	0	27	2	0	0	0	0	0	0	0	0	0	0	0	29
2	0	1	36	0	0	0	0	0	0	0	0	0	0	0	37
3	0	0	3	82	2	0	0	0	0	0	0	0	0	0	87
4	0	0	0	5	101	4	0	0	0	0	0	0	0	0	110
5	0	0	0	0	4	15	1	0	0	0	0	0	0	0	20
6	0	0	0	0	0	2	6	0	0	0	0	0	0	0	8
7	0	0	0	0	0	0	2	11	2	0	0	0	0	0	15
8	0	0	0	0	0	0	0	2	6	1	0	0	0	0	9
9	0	0	0	0	0	0	0	0	3	17	1	0	0	0	21
10	0	0	0	0	0	0	0	0	0	2	2	1	0	0	5
11	0	0	0	0	0	0	0	0	0	0	1	8	1	0	10
12	0	0	0	0	0	0	0	0	0	0	0	1	2	0	3
14	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
Total	3	28	41	87	107	21	9	13	11	20	4	10	3	2	359



Appendix Figure 1.Agreement between primary 4X5Y haddock ager and reference collection ages (0-14) (Comeau versus Reference Collection 2011).